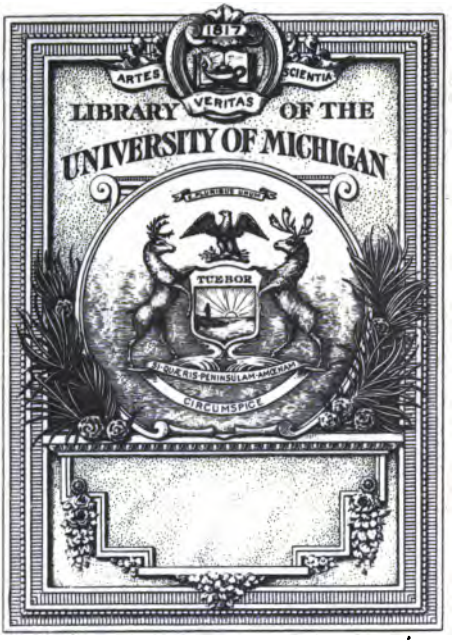

STUDIES IN HEMIPTERA

DISSERTATION

PRESENTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN THE GRADUATE SCHOOL OF THE OHIO STATE UNIVERSITY

BY
CARL JOHN DRAKE

The Ohio State University
1922

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THE QUARTERLY BULLETIN

State Plant Board of Florida

Vol. IV APRIL, 1920 No. 3

THE SOUTHERN GREEN STINK-BUG* IN FLORIDA

CARL J. DRAKE†

A large green plant-bug, *Nezara viridula* Linn., has long been known as a serious plant and fruit pest in Florida. In 1885 Hubbard‡ (notes and excerpts from correspondence) calls attention to the sudden rise of this insect into economic importance and briefly discusses its depredations upon a number of garden vegetables, truck plants and field crops in addition to the orange trees. During the last decade the insect has been greatly increasing in numbers and its ravages have been especially great, not only in Florida, but in other states bordering on the Gulf of Mexico.

The observations and investigations herein recorded were carried on chiefly at the University of Florida Experiment Station, Gainesville, Florida, during the summer of 1918. All original illustrations, except figures 7, 17, 33, 37 and 39, have been made by the author. Mr. W. C. Wessel has kindly made the drawings for figures 7, 17 and 33. I am indebted to Prof. J. R. Watson for securing the photograph for figure 39, and to Prof. J. B. Thompson for kindly loaning the negative for figure 37. Several illustrations have been secured from the United States Department of Agriculture, the Ohio Agricultural Experiment Station and the Agricultural Experiment Station of the University of Florida; these are duly credited when used herein. At this opportunity the author wishes to express appreciation to Prof. J. R. Watson and to Dr. E. W. Berger for kindly turning over the correspondence and records of the Experiment Station and Florida State Plant Board, respectively, relating to the project and for much valuable criticism and advice. Thanks are also due Mr. Wilmon Newell, Plant Commissioner, for going over the manuscript and suggesting changes. The food plants have been determined largely by Professors Thompson and Watson. Through the co-operation of the County Agents, University of

**Nezara viridula* Linn.

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‡See footnote, page 52.

Florida Agricultural Extension Division and the Florida State Plant Board staff many living specimens were secured from various parts of the State. A number of farmers and citrus growers have also kindly sent in specimens for breeding purposes.

HISTORICAL

This plant-bug was first described by Linnaeus in 1758 (p.444) under the scientific name *Cimex viridulus* from specimens collected in India. Since then, according to Van Duzee‡ (1917b, p. 58), the insect has been redescribed under numerous other scientific names by various authors. The species is now placed in the genus *Nezara* of Amyot and Serville. Three good color varieties are recognized; namely, *smaragdula* (Fabricius), *torquata* (Fabricius) and *hepatica* Horvath. These color varieties are not known to occur within our limits.

Nezara viridula, like many of our most destructive insect pests, is of foreign origin and was undoubtedly imported to the West Indies and North America many years ago. Owing to the paucity of data it is impossible to conjecture how, when, or even where the insect was introduced into Florida.

CLASSIFICATION AND COMMON NAME

Nezara viridula (Linn.) belongs to the group of insects commonly called the "true bugs" or the suborder Heteroptera of the order Hemiptera. It is placed in the "stink-bug" family called Pentatomidae. The pentatomids are widely known as "stink-bugs" because they emit a very malodorous and ill-tasting substance for protective purposes. This insect is known by a number of common or popular names as the "green-bug," "tomato and bean-bug," "southern green plant-bug," "pumpkin-bug," "green soldier-bug," "green-bug of India," etc. On account of its distribution in the United States (southern part), color (light green), and widely known family name (stink-bug), I have used the name "southern green stink-bug" as a common name for it.

THE ADULT

The adult (typical form) southern green stink-bug (Fig. 6) is a large light green shield-shaped bug. Over-wintering specimens and pinned specimens in collections are sometimes slightly faded, the light green being more or less replaced by a brownish or purplish hue. The average sized individual is about ½-inch

‡The numbers (years and pages) in parenthesis refer to bibliography, the papers being arranged chronologically for each author. The authors are arranged alphabetically.

long and about 1/3-inch in width. Both male and female are slightly variable in size, the female usually being a little larger than the male. The antennae or feelers are each composed of four segments. The legs and wings are well developed. The beak or rostrum is four-jointed.

Fig. 6.—Adults of the southern green stink-bug (*Nezara viridula*), natural size. (After Watson, Bull. 148, Fla. Agr. Exp. Stat.)

The variety *torquata* (Fabricius) differs from the typical form in having the head, except for a distal green spot, anterior portion of thorax, three small spots at the base of the scutellum, and the connexivum yellow. The variety *smaragdula* (Fabricius) is of the usual green color, but can be readily distinguished from *torquata* by having only three rather large yellow spots at the base of the scutellum. The variety *hepatica* (Horvath) is somewhat similar to the variety *torquata,* but the green color above is replaced largely by sordid brown. The anterior portion of the head and thorax, the basal portion of the scutellum and a mark on the wing are stramineous.

Closely Allied Species

Four closely related species of pentatomids, *viridula* Linn., *hilaris* Say, *pennsylvanica* DeG. and *marginata* P. B., occurring in the United States, usually have been placed in the genus *Nezara* of Amyot and Serville, the genus *Acrosternum* of Fieber being considered a synonym of *Nezara.* Dr. Bergroth (1914, p. 25), on the structure of the osteolar canal (Fig. 10, o= osteolar canal) and on the structure of the male genitalia as noted by Sharp (1890, pp. 406-408), pointed out the generic differences between the two genera and raised the genus *Acrosternum* to a valid genus. This leaves only *viridula* Linn. in the genus *Nezara,* the other three species falling in the genus *Acrosternum.* All four of these insects occur in Florida.

Acrosternum marginatum P. B. is a rather rare insect and seems to be a tropical species. It has been reported from southern Florida. Nothing is known of its life history or habits.

Acrosternum pennsylvanicum DeG. is a widely distributed species in the United States. During the summer three specimens were sent to the Florida State Plant Board from Fort Myers. These specimens were taken with a long series of *Nezara viridula* on orange trees and on garden and truck plants. The writer collected one specimen on a small scrub oak near Gainesville on July 4. Lugger reports the species on grape in Minnesota. No report has been made on its life history or habits.

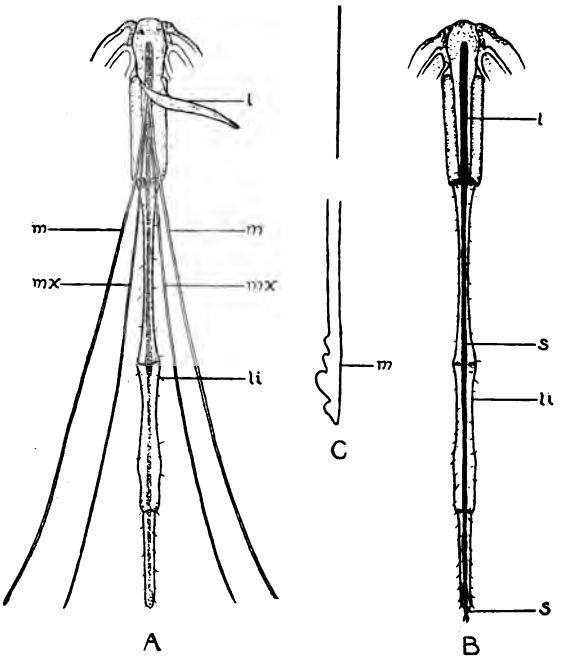

Fig. 7.—Mouthparts of the southern green stink-bug (*Nezara viridula*) :A, dorsal aspect with setae separated; B, dorsal aspect showing setae in normal position within sheath; *l*, labrum; *li*, labium; C, tip of mandible greatly enlarged; *m*, mandible; *mx*, maxilla; *s*, setae within sheath (labium); *s'*, tips of setae. Enlarged. (Original, from drawing by Wessel.)

Acrosternum hilaris Say is commonly known as the northern green soldier bug. In fact *N. viridula* has often been confused in literature in the South under this name. The northern green soldier bug is a transcontinental form that occurs over the greater portion of the United States, becoming more abundant in the northern states. It is distinctly a shrub-inhabiting species, only occasionally being found on herbaceous plants. In this respect its habits are quite distinct from those of the southern green stink-bug *Nezara viridula,* which is primarily an herb-inhabiting form. These two species resemble each other very closely in color, form and size, but they can be readily separated by the shape of the osteolar canal (Fig. 10; o=osteolar canal).

The habits and life history of the northern green soldier-bug have been published by Whitmarsh (1917). In Ohio it occasionally does a considerable amount of damage to peaches. The food plants listed in literature are box elder, dogwoods (*Cornus*

florida and *C. alternifolia*) wild cherry (*Prunus serotina*), black-haw, common elderberry, catalpa, apple, peaches, oranges, corn, okra, golden rod, egg-plant, cabbage, beans, cotton and seed pods of mesquite (growing near cotton fields in Texas). Less than two dozen specimens of this insect were seen by the author during the entire summer in Florida. In the vicinity of Gainesville the author took it upon *Crataegus* sp. (adults and one egg cluster after incubation), rattle-box (*Crotalaria*), mulberry, wild plum, hop hornbean or ironwood, castor bean and blackberry. The specimen on *Crotalaria*, collected August 10, bore eggs of a tachinid parasite, *Trichopoda pennipes*, the parasite being reared in the insectary. Many specimens of pentatomids and other plant feeding insects were received at the Experiment Station and State Plant Board from various parts of the state during the summer but *A. hilaris* was represented by only four specimens. Several species of brown stink-bugs, belonging to the genus *Euschistus*, also feed upon citrus trees and cultivated plants. The brown color will readily enable one to distinguish them from either *Nezara* or *Acrosternum*.

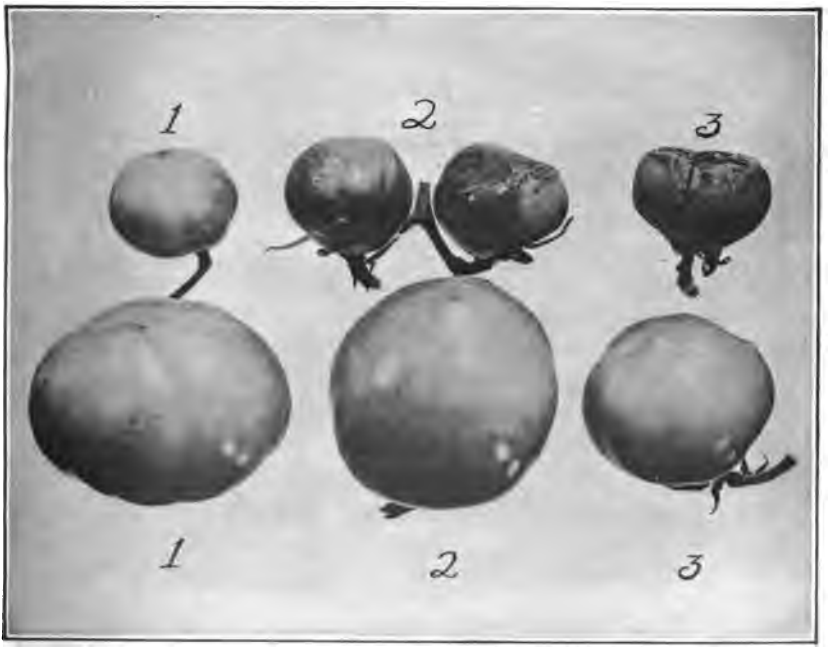

Fig. 8.—Injury to tomato fruit by nymphs of the southern green stink-bug (*Nezara viridula*): Injured fruit above, normal fruit below. Developing fruit was covered with cheesecloth sacks in which nymphs were confined. Fruit bearing same numbers were approximately the same size when enclosed in sacks.

DISTRIBUTION

The southern green stink-bug is one of the most universal and widely distributed species of plant feeding insects. In fact it is found throughout the tropical and neotropical regions of almost the entire world. Lethierry and Severin (1893, p. 167) give its distribution as Europe, Asia, Africa, and America. Numerous records have been published for the West Indian Islands, northern

Fig. 9.—Puncture marks on radish pods caused by the feeding of both nymphs and adults (*Nezara viridula*). Slightly enlarged. (Original, photo by author.)

portion of South America, Central America, Mexico and the southern portion of the United States. Distant (1880, p. 79) states that the wind has probably greatly assisted the insect in its wide dissemination; while sailing from India he found several specimens which had been blown aboard the ship when more than a hundred miles southwest of Madagascar.

In the United States VanDuzee (1917, p. 58) catalogs the species for Virginia, Florida and Louisina. In addition to these states Jones (1918, p. 11) lists California, Arizona, New Mexico, Texas, Mississippi, Alabama, Georgia, and South Carolina. Bueno (1912, p. 316) records the finding of a specimen in a greenhouse in Brooklyn, New York, and states that it was probably brought in on plants from Florida or introduced from Europe. Prof. J. G. Sanders kindly sent the writer two specimens which were col-

lected at Hummelstown, Pennsylvania, by Mr. J. N. Knull. The numerous published records and the many letters in the files of the Florida Experiment Station and the Florida State Plant Board show that the insect is common over the entire state of Florida, often becoming a serious pest in many places.

Food Plants†

In nature the southern green stink-bug feeds upon many different kinds of plants. It is distinctly an herb-inhabiting and herb-feeding species; only occasionally are shrubs and trees infested. All parts of a plant are attacked, but it is particularly at home on the fruit and on the tender growing shoots. This applies to the nymphs (the young) as well as to the adults.

Fig. 10.—Ventral view showing (o) osteolar canal: a, *Nezara viridula*; b, *Acrosternum hilaris*. Enlarged, photo by author.

Various authors have cited the insect as feeding on radish*, mustard*, turnip, collard*, cauliflower, cabbage, okra*, beggarweed*, peas*, cowpeas*, peanut*, beans*, tomato*, potato, tobacco, Brussels sprouts, sweet potato, cotton*, pepper, *Gynandropsis pentaphylla*, eggplant, sunflower, sugar cane, corn or maize, rice, pecan, lime, peaches, grapefruit, orange*, lemon, hackberry and mulberry. In addition to a number of the above plants the writer has found the insect feeding on rattle-box* (*Crotalaria usaramoensis*), everlasting pea* (Lathyrus sp.), butterfly pea* (*Clitoria* sp.), Mexican clover* (*Richardsonia scabra*), sorrel* (*Rumex* sp.), wild blackberry, wild grape (*Vitus* sp.), castor bean*, passion flower or maypops* (*Passiflora incarinata*), wild plum (*Prunus* sp.), an introduced cereal plant* (*Amaranthus leucocarpa*), spiny amaranth* (*Amaranthus spinosus*), *Amaranthus* spp.* (two wild

†In addition to the plant feeding habit Hubbard (1885, p. 159) reports that the insect is, to a certain extent, predaceous. Prof. J. R. Watson can state irrefutably that the insect will sometimes bite man. The writer has failed to observe or to make the insect feed upon other insects and in handling several hundred speciments has never been bitten.

*See footnote p. 48.

species), nut grass* (*Cyperus esculentus*), lamb's quarters*, (*Chenopodium acuminatum*), chayote*, cucumber*, pepo or crook-neck squash*, Japanese pumpkin*, sandbur or bur grass* (*Cenchrus sp.*). In late fall specimens have been taken on pokeweed by Dr. Berger, and on dwarf Essex rape by Prof. Watson. The insect feeds upon all varieties of cowpeas, peas and beans, but not enough data have been collected to determine the varieties less susceptible to attack.

The long list of food plants shows that the insect is a very general feeder and that it can subsist upon a great variety of plants. However, it probably does not breed, at least in great numbers, on all these plants and only occasionally feeds on a number of them. Observations show that the insect has a very decided preference for a few plants. This preference, of course, varies with the development of the preferred food plants and in different seasons of the year. Watson (1918, p. 231), states "It breeds particularly on such legumes as cowpeas and beggar-weed and when these plants are grown as a summer crop in the (citrus) groves and allowed to stand too long, the bugs attack the citrus fruit." Jones (1918, p. 14) states "In the late fall and early winter the various stages are often abundant on mustard and turnip." The author found radish and collard (both growing in the same row) to be greatly preferred by the bugs in spring and early summer; in fact so alluring that tomatoes and other garden and truck crops growing in the same patch or even in adjoining rows were scarcely infested at all. Rattle-box, an introduced forage plant on the Station grounds, proved to be one of the most attractive plants to the insects during July, August and September; this plant served a double purpose as the parasites were greatly attracted by its flowers. The marked preference for preferred food plants, such as radish, cowpeas, rattle-box and begger-weed, is greatest by far during the period of fruit formation. After the fruit is mature and lignification has set in, the bugs wander to more succulent plants. This was nicely illustrated during

Fig. 11—Male and female of the southern green stink-bug (*Nezara viridula*) in the act of mating. Slightly enlarged. (Original, photo by author.)

*Eggs or young nymphs were found on this plant at Gainesville during the summer of 1918 by the author.

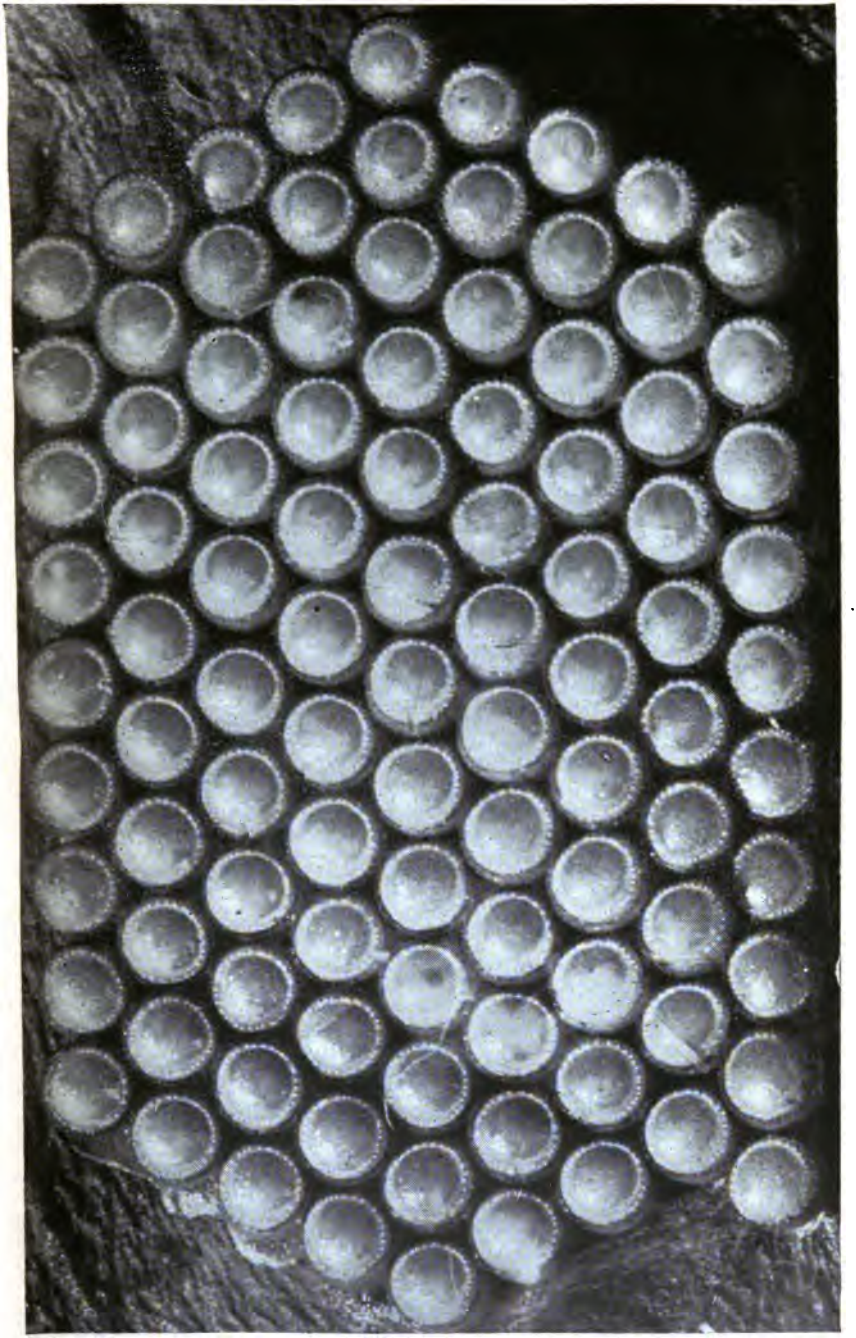

Fig. 12.—Egg cluster of the southern green stink-bug (*Nezara viridula*) before hatching. Greatly enlarged. (Original, photo by author).

the summer on some plots of cowpeas that matured on slightly different dates. The difference of time of maturing was due to different varieties of plants or that the same variety had been planted on different dates. Young plants were not at all or only slightly infested while fruiting plants were usually very severely infested. On the other hand, mature plants, as a rule, were only

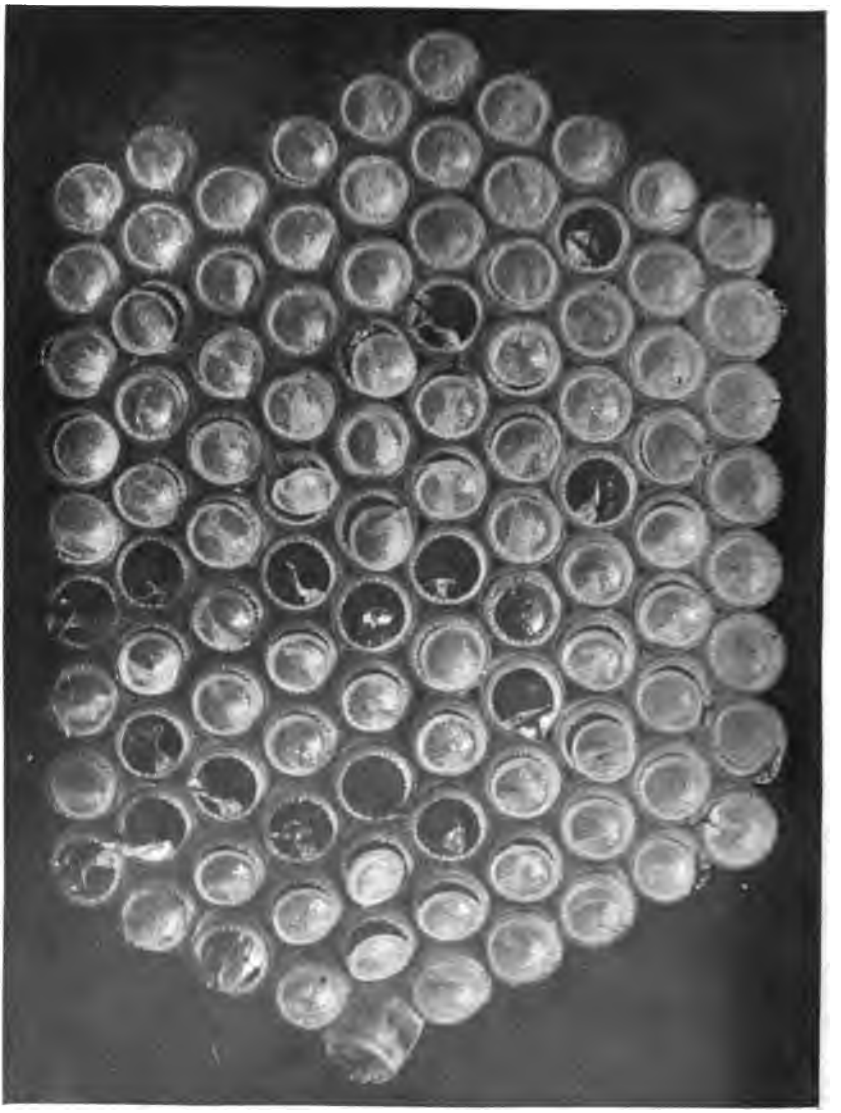

Fig. 13.—Egg cluster of the southern green stink-bug (*Nezara viridula*) after hatching. Greatly enlarged. (Photo by author.)

slightly infested because the bugs, as they matured, migrated to other food plants. No food plants, the preferred ones included, are desirable for the bugs after the fruit has matured or lignification has set in.

Method of Securing Food

The mouthparts of the southern green stink-bug (as in all Hemiptera) are modified to form a structure for piercing and sucking. This structure (Fig. 7) is known as the beak or rostrum and when not in use it is carried flat close to the ventral portion of the body between the legs (Fig. 10). This beak or rostrum is an elongated, four-jointed, tube-like structure, containing four long, lance-like setae (Fig. 7; B). The thicker and heavier pair of setae are called the mandibles (Fig. 7; B. m) and the thinner pair the maxillae (Fig. 7; B. mx). These four setae, the mandibles and maxillae, are sharp-pointed structures which pierce and enter the plant when the bug feeds. It is capable of taking only liquid food.

Nature of Injury and Economic Importance

Both nymphs and adults obtain their food by puncturing the tissues of plants with their beaks and then extracting the plant juices. They attack all parts of a plant, as stem, foliage, flower and fruit, but greatly prefer the young tender growth and fruit. The numerous feeding punctures, caused by the insertion of the rostrum, make minute, hard, brownish or blackish spots on the plant. These spots are not only unsightly, but sometimes they are the avenue for infections and decay.

On mature fruit, the feeding punctures seriously mar its ap-

Fig. 14.—Later view of the eggs of the southern green stink-bug (*Nezara viridula*) on radish pod. Greatly enlarged. (Photo by author.)

pearance, greatly affect its edible qualities, and decidedly lower its market value. Such fruit is consigned to an inferior grade, or in the case of severe infestation it becomes worthless and must be discarded. Attacked, young immature fruit is much retarded in growth and greatly distorted, or hard callouses form around the punctures. Sometimes it even drops from the plant before or after maturity. Young plants and young growing shoots are greatly retarded by their attacks and, occasionally, they are even entirely destroyed or fail to bear fruit. Such injury has been noted on a number of cultivated plants in gardens

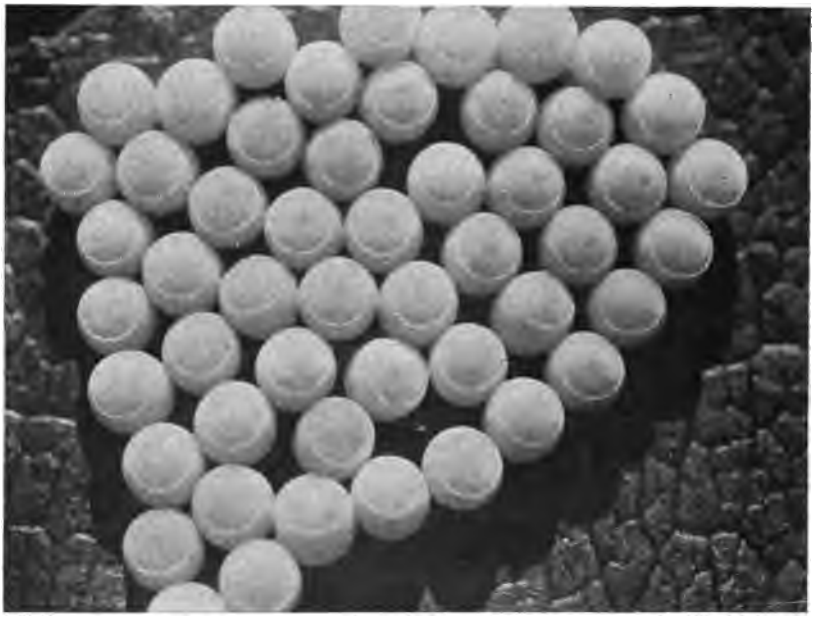

Fig. 15.—Egg cluster of the northern green soldier-bug (*Acrosternum hilaris*). Greatly enlarged. (After Whitmarsh, Bull. 310, Ohio Agr. Exp. Stat.)

and fields, also on young orange trees and on the tender growth of older trees.

To quote from the first published account of the ravages of this insect by Hubbard* (1885, pp. 159-161; from correspondence of James Franklin, West Apopka, Fla., Jan. 31, 1883):

"They mature very quickly, and increase with surprising rapidity, continuing to breed until November. In the spring and early summer they

*Hubbard gives this account under "The Green Soldier Bug" or *Raphigaster hilaris* Fitch, but he undoubtedly refers to *Nezara viridula* Linn. as *hilaris* Say (the northern green soldier-bug) has never been known to occur in great numbers in Florida. Riley and Howard (1893, p. 264) state "* * * the species which he (Hubbard) figures upon page 160 is in all probability the same as your number 2 (*Nezara viridula*) * *."

confine their attacks principally to garden vegetables and succulent weeds. They are particularly abundant on tomato vines, egg-plants, turnip tops, and mustard, seldom doing much damage to the orange trees at this season. When pea-vines are well grown, about or a little before the time of blossoming, they abandon nearly everything for the pea-vines. Last year they totally destroyed my garden. Not one tomato came to perfection. Where the insect had inserted its sucking-tube a reddish yellow spot appeared. When cut the fruit was full of lumps and totally devoid of flavor. The tomato vines grew so enormous a crop that the ground was almost covered by the fallen fruit. Last year I had 35 acres planted in cow-pea vines, which bore an enormous crop of peas; but not enough sound peas could be gathered to plant 5 acres of additional land. Later it was impossible to find a sound pea. I attempted to turn under the vines, but so luxuriant was the growth that it could not be done. Towards the end of August the pea-vines were dead or dying, when the bugs swarmed to the orange trees, killing nearly all the new growth. Immense numbers were killed by keeping men constantly going over the grove, shaking the trees, and killing all that fell on the ground. The wingless individuals were readily killed, but a large number of mature insects saved themselves by flight. * * * The number of insects is incredible. When thoroughly shaken, the ground under the trees would be alive with fallen insects, and two days later just as many would be found."

Watson (1918 a, p. 59R) gives the following report of the insects on citrus:

"Many complaints of damage done to citrus by plant-bugs were received in October and November. Plant-bugs attack the young shoots of the trees causing them to wilt and die. In young groves they often do considerable damage in this way during the summer. On large trees the damage is negligible. It is the fruit that sustains the most severe damage. This turns yellow around the punctures which, if sufficiently numerous, cause the fruit to fall. These fruits are dry and tasteless, the juices having been withdrawn by the bugs. Tangerines are most severely attacked; oranges are the second choice, while grapefruit is not much troubled."

Many complaints were received during the past year (1918). A letter from Mr. F. D. Waite of Palmetto, Florida, states:

"We estimate that we threw away one thousand crates of tomatoes which were bug-sucked and 500 crates put in seconds that were damaged to some extent by the same bug. The damages or loss, at prices received during the past season, would amount to at least $4,000 on 14 acres of staked tomatoes. As they were staked we were able to gather the bugs

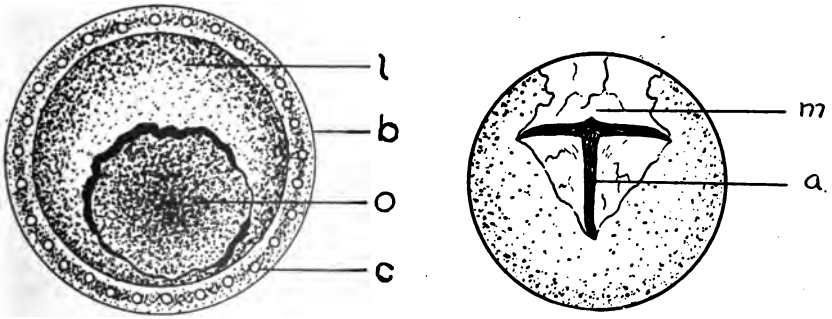

Fig. 16.—Dorsal aspect of the eggs of the southern green stink-bug (*Nezara viridula*): *l*, disc-shaped lid or cap; *b*, outer wall or barrel of eggshell; *c*, chorial process; *o*, hole in lid made by egg-parasite in escaping from the egg; *a*, T-shaped egg-burster; *m*, membrane. Enlarged. (From drawing by Wessel.)

by hand and employed women and children almost constantly for two months. The bugs at first were noticed working on what we call cockspur weed around the margins of the tomato fields."

"The bugs have been increasing every season and we find them all over our 500 acres of groves, but only twice have they done much damage to the oranges."

Dwarf Essex rape is a very desirable food plant during late fall and winter. Prof. Watson states:

"There are thousands of the bugs on this plant in the fields during December. In fact it seems to be one of the most attractive plants just now. There is a distinct tendency to collect in colonies, a tendency not observed in summer time. Under some leaves I found as many as a dozen adults in a group. I could easily see where the bugs were when the bugs themselves were out of sight. Even one bug on a leaf seems to be capable of wilting it. Only a very few specimens bore tachinid* eggs on their bodies. I noted an adult tachinid fly the other day, but they are quite scarce now."

Dr. W. E. Hinds states that *Nezara viridula* has done extensive damage in southeastern Alabama, particularly in the fall of 1916. He believes that the insect is spreading and increasing in injuriousness in Alabama (from Station correspondence).

In Georgia, Turner (1918, p. 491) reports the insect as a serious enemy upon pecans, and that there was a severe infestation during 1916. In the groves, cowpeas are commonly grown as a soiling crop during the summer, the vines being turned under late in the fall. In September or early October, after the cowpeas have matured and the vines begin to dry up, the bugs leave the cowpeas and migrate to the pecan trees. In some cases the

Fig. 17.—Nymphs of the southern green stink-bug (*Nezara viridula*) showing gregarious habit during first instar. Enlarged. (Photo by author.)

*See family Tachinidae, p. 67.

bugs have been observed feeding upon the nuts. Experiments are being conducted by Turner to determine the relationship between the feeding punctures of the bug and the kernel spot of pecan. So far the data obtained strongly indicate that *Nezara viridula* is an important agent in either the actual production or the dissemination of the disease. Similar experiments with *Nezara viridula* and other plant feeding bugs, are being conducted by Nowell (1918, p. 217), in the West Indies, on the internal diseases of the cotton boll.

In India, Atkinson (1889, p. 4) calls the insect the "green bug of India" and states that it did considerable damage, in 1889, to the potato halms. According to Froggatt (1916, p. 649) the species has been recently introduced into Australia and the number of individuals has been increasing very rapidly. In the neighborhood of Sidney it is a pest upon potatoes, tomatoes and French beans. It is commonly called the "tomato and bean-bug" in Australia.

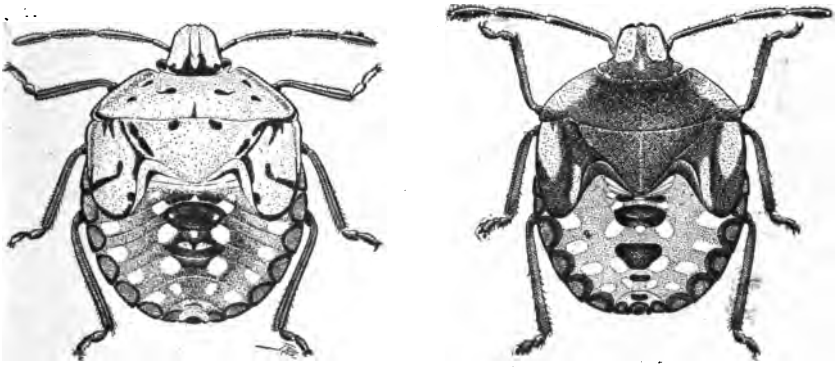

Fig. 18.—Light and dark colored forms of the southern green stink-bug (*Nezara viridula*); fifth instar, enlarged about 4 diameters. (After Jones, Bull. 689, U. S. D. A.)

Habits and Life History

Hibernation

In Florida, as well as in the other states bordering on the Gulf of Mexico, the hibernation of the southern green stink-bug is only partial, a few of the adults remaining upon succulent plants throughout the entire winter. Watson (1918 b, p. 232) states: "They are abundant in October, plentiful in November, common in December but rather scarce in January and February." In the southern portion of the state the bugs are more abundant and active during the winter months. Many stragglers

or belated nymphs of the last brood are found in the fields during late fall and early winter. These, at least the most of them, are able to mature and to seek favorable hibernating quarters during the warmest hours of the day. However, there are no winter broods in the State and only adults are found throughout this season of the year.

The hibernating forms secrete themselves beneath the loose bark of trees and logs, among and beneath fallen leaves, in

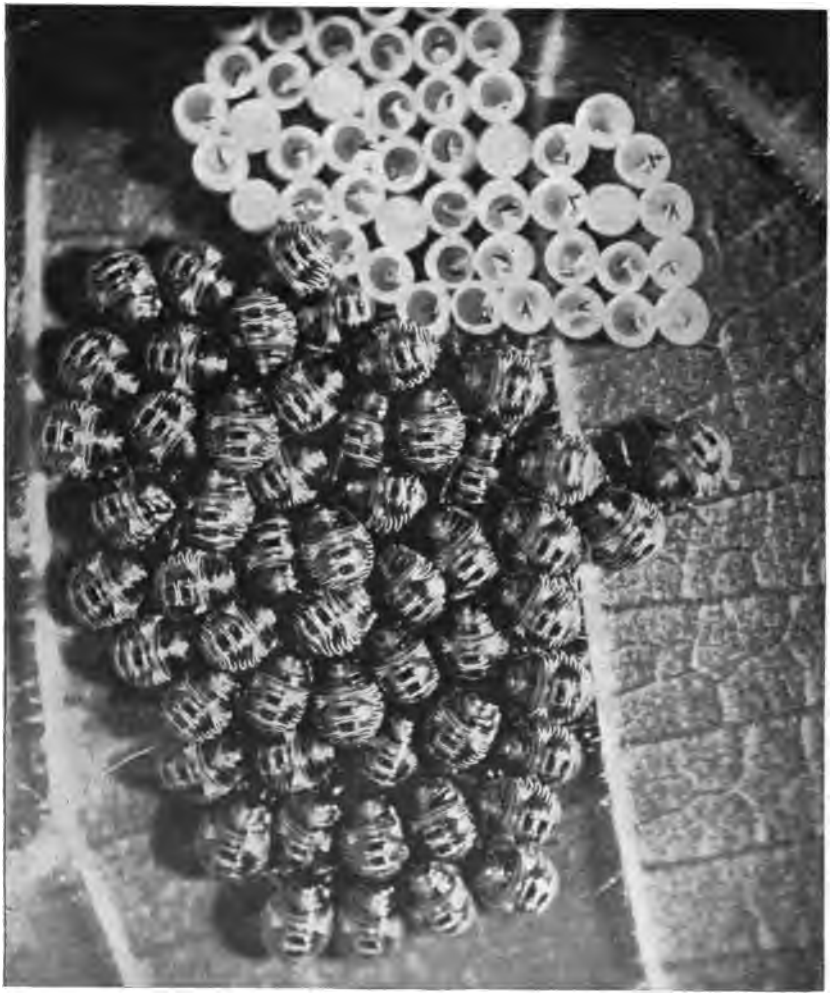

Fig. 19.—Cluster of nymphs of the northern green soldier-bug (*Acrosternum hilaris*) showing gregarious habit during first instar. Greatly enlarged. (From Whitmarsh, Ohio Agr. Exp. Stat. Bull. 310.)

Spanish moss, under boards and sticks and in almost any secluded place that offers a slight protection from the weather. In Louisiana, Rosenfeld (1911, pp. 401, 403, 404 and 405) enumerates the species among the insects and spiders found hibernating in Spanish moss during the months of December and January. Dozier found several specimens beneath the bark of dead "live oak" on the campus of the University of Florida. Prof. Watson states that hammocks afford the most favorable retreats for the bugs in Florida and that the food plants, either wild or cultivated growing close to hammocks are the first to become badly infested in early spring. The individuals that overwinter on food plants afield are quiet and somewhat sluggish or even torpid on cold days, but rather active and often feed during the warmest hours of warm days during mild weather.

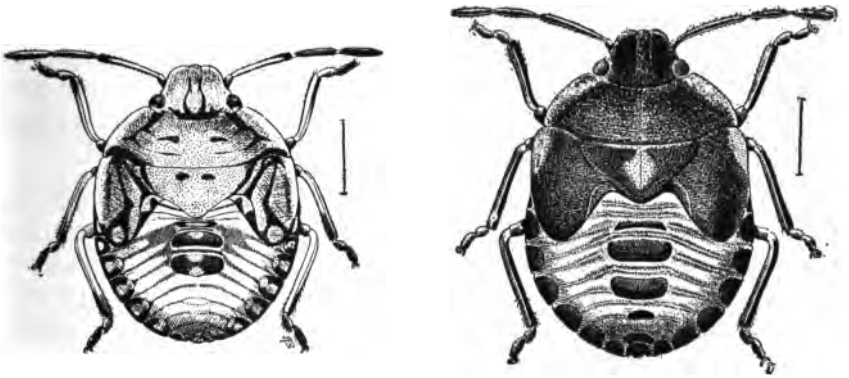

Fig. 20.—Light and dark colored nymphs of the northern green soldier-bug (*Acrosternum hilaris*); fifth instar. Enlarged about 4 diameters. (After Jones, Bull. 689, U. S. D. A.)

Copulation

On the approach of warm days in early spring the hibernating forms wander from their secluded winter haunts in search of food. Mating begins almost immediately. This is about the middle of March or a little later in the vicinity of Gainesville and somewhat earlier in the southern part of the State. During copulation the male and female (Fig. 11) face in an opposite direction with the caudal extremities of their body together. They are somewhat sluggish at this time and are not readily disconcerted. If molested, they fall to the ground, usually not becoming detached from each other. No pairs have been observed in flight while mating, but feeding continues normally. The process has been timed and found to vary considerably in different

pairs. It is not uncommon for a pair to remain constantly *in coitu* for a day or even longer. Under natural conditions copulation is repeated a number of times until the eggs have been deposited.

Both field and laboratory observations show that the males are polygamous and the females polyandric. After feeding a few days newly emerged adults reach sexual maturity. This period was found to vary from about three to five weeks or in some cases even longer.

Oviposition

At Gainesville, the overwintering adults begin to deposit eggs about the middle of April. The eggs are usually placed in very regular clusters (Figs. 13 and 14) upon the surface of the host plants, preferably on the underside of the leaf, where the insects are feeding or resting. At the time of deposition the eggs are covered with a viscid liquid which glues the eggs to one another and to the surface of the plant upon which they are laid.

The process of egg-laying has been observed by the writer in the laboratory. The first eggs are deposited so as to form an inverted V-shaped row (Fig. 12, top of page). This forms two of the narrower sides of the cluster. After depositing this row the female remains in the angle of the V. Just as she is ready to lay another egg, she puts her ovipositors against the egg at one end of this row, then tilts her body slightly forward and drops an egg. As the egg leaves her body it is guided by the ovipositors and placed on end with the cap or disc-shaped lid up against the other eggs. The ovipositors are immediately placed against the sides of the freshly laid egg, probably to straighten it slightly and to hold it in its normal position for an instant while the glue hardens. In a like manner another egg is laid, and thus the process continues until the entire egg cluster has been deposited. One, two or even three rows may be in the process of formation at a time. Only a few seconds are consumed in dropping and placing an egg in its normal position, but the interval between the laying of two consecutive eggs varies in different females from one to four minutes. Ordinarily, the average sized egg cluster is deposited in about an hour and a half to two or three hours.

The Eggs

The Egg Cluster.—The eggs are generally laid in regularly shaped, compact, hexagonal clusters in which the individual eggs are arranged in very regular rows and firmly glued together. Figures 12 and 13 illustrate the two most common forms of egg

Fig. 21.—Adult of southern green stink-bug (*Nezara viridula*) bearing eggs of a tachinid parasite (*Trichopoda pennipes*). Enlarged. (Photo by author).

clusters found in the field. At the time of deposition the eggs are light yellowish white or cream in color.

During the summer of 1918 many egg clusters, which had been deposited by insects not in confinement, were collected on various food plants in the fields. These egg clusters, with one exception, were composed of from 61 to 126 eggs. A small cluster found on a radish pod during the third week in May contained only 46 eggs. In Louisiana, Jones (1918, p. 15) states: "Egg clusters deposited outside of confinement and examined by the writer have, with one exception, been made up of from 60 to

116 eggs. A cluster taken on November 3 contained only 36 eggs."

The Egg.—The egg (lateral view, Fig. 15) is light yellowish-white in color, somewhat cup-shaped, flat on top, the top being closed with a disc-shaped cap or lid. On the top quite regularly arranged in a circle around the disc-shaped cap or lid are about 30 delicate, club-shaped, chorial processes. These processes are attached by their smaller ends, the larger ends usually pointing obliquely upwards towards the center of the lid. The outer surface of the chorion, or egg-shell, shows minute traces of hexagonal markings. The egg is a little longer than wide, being about 1/20 of an inch in length and 1/29 of an inch in width.

According to Whitmarsh (1917, p. 523) the egg of the green soldier bug, *Acrosternum hilaris* (Fig. 15) has about 65 chorial processes on top of the egg. The author agrees with Jones (1918, p. 5) in finding the number of chorial processes on top of the egg of the southern green stink-bug, *Nezara viridula* (Figs. 13 and 14) to range from 28 to 32. The number of chorial processes will readily enable one to discriminate between the eggs of the two species.

Fecundity of the Females

Numerous adults, reared from eggs deposited in the insectary or from both eggs and nymphs collected in the field, were placed in breeding cages and kept until their death. These reared adults, a male and female being placed in each cage, were confined in ordinary glass tumblers or glass stender dishes until their death. Green tomatoes, radish pods, and cowpea pods were used almost exclusively for food.

Fig. 22.—Hole through body of host (*Nezara viridula*) made by young maggot of tachinid fly (*Trichopoda pennipes*), egg-shell removed. The young tachinid maggot escapes from the egg by making a hole through the attached or flat side of the egg-shell and body wall of host. Greatly enlarged. (Photo by author.)

The number of eggs and the number of clusters of eggs deposited by different females are somewhat variable. The majority of the females only laid one cluster of

eggs, but several laid two clusters and a few laid even three. On the other hand, a few females never deposited any eggs at all. In some cases eggs were found at death in the ovaries of females that had deposited no eggs or that had deposited one, two or even three clusters of eggs; in other cases no eggs were found. One of the females, which had deposited three clusters of eggs (78, 70 and 64 eggs respectively), laid a total of 212 eggs. No eggs were found in her ovaries at death. In Louisiana, Jones (1918, pp. 16 and 17) states that a female deposited a total of 240 eggs (3 clusters of 87, 83 and 70 eggs respectively) and that 77 eggs were found in her ovaries at death. Most of the females deposited an egg cluster in about three to five weeks after becoming an adult.

Incubation

Early in the incubation period the eggs begin to turn pinkish and a red crescent spot appears on the lid or cap. These colors gradually grow deeper and more conspicuous until hatching. After hatching the chorion, or egg-shell, is whitish. The average time for incubation during the summer is about six days. A few clusters have hatched in four days, but during early spring and late fall the period of incubation is often greatly extended, the time varying from about two to three weeks and sometimes a little longer. This variation in time, of course, is due largely to the fluctuations in temperature during the different seasons of the year. No attempt has been made to find the effects of moisture or the direct rays of the sun upon incubation.

The method of hatching is similar to that of many other pentatomids. The nymph escapes through a circular opening at the cephalic or head end of the egg by opening the disc-shaped cap or lid. The lid is opened by means of a T-shaped structure called the egg-burster or lid-opener (Fig. 16), the cap usually remaining attached to one side of the egg-shell. By means of pressure from below, the lid is loosened and forced upwards and the head of the nymph, surmounted by the egg-burster, gradually makes its appearance beneath the partially opened lid, the legs and antennae being closely appressed to the ventral surface of the body and directed posteriorly. The emergence is rather slow, the nymph gradually working its way out until the antennae and legs are free and only the tip of the abdomen remains in the egg-

shell. The nymph is thus held in an erect position, but, as soon as the antennae and legs are capable of free movement, the nymph pulls the tip of the abdomen out of the egg-shell and walks to one side of the cluster or slightly off of it. Here it remains quiet in a resting position with the other newly hatched nymphs (Fig. 17) for a few days. The hatching of an egg cluster usually takes place irregularly, thereby giving room for the movement of the appendages while the emerging nymph is held in an erect position. Normally, about five or six minutes are consumed from the time the nymph makes its appearance beneath the partially lifted lid until it has entirely escaped from the egg, the entire egg-cluster generally hatching in about an hour and a half. The egg-burster or lid-opener (Figs. 13 and 16) usually falls back in the egg-shell, being attached to one side by a thin, delicate membrane. Sometimes both the egg-burster and the disc-shaped lid may be entirely removed from the egg-shell during hatching.

Nymphal Instars*

The immature form is represented by five nymphal instars. Each of these instars is quite distinct and displays characters and color patterns which are sufficient to discriminate the instar. The antennae of the nymphs are each composed of four segments, the adult having five. No wings are present, the fifth instar having only wing-pads. In moulting or shedding its skin the outer skin splits open on the dorsal surface along the median line of the head and thorax and the nymph gradually works its way out, leaving the old cast-off skin behind. The nymph moults five times before reaching the adult state.

First Instar.—At the time of hatching the nymph is slightly longer than the egg, oval in outline, strongly convex, and with the antennae and legs quite stout. The general color is light yellowish orange with the eyes and a broad inverted v-shaped mark on the head crimson. Sometimes, there are traces of crimson lines on the thorax and abdomen. The legs, antennae and beak are without much color and nearly transparent.

In a short time the general color gradually grows darker and the color markings begin to make their appearance. The mature form, just before moulting, is about 1/16 of an inch long and 1/23 of an inch wide. The eyes are deep red and the broad inverted v-shaped area on the head is either crimson or brown. The thorax is brown, with the central portions of pro- and mesothorax yellow. The abdomen is generally darker than the head and thorax, being mostly dark brown or nearly black. On either side of each segment there is a nearly semicircular, yellowish or yellowish-brown spot. The three somewhat rectangular areas, the anterior one much narrower than the others, are dark reddish brown. In addition to these markings there are usually four white or cream-colored spots on the abdomen.

*For a technical description of the different nymphal instars, see Jones, 1918, pp. 8-11.

The body beneath is yellow tinged with red, becoming darker on the abdomen. The semicircular, yellowish spots, as noted on the dorsal surface of the abdomen, are usually present. The legs, antennae and beak are light yellow, the tip of each dusky.

During the first instar the nymphs normally cluster together (Fig. 17) near or on the egg-shells. No individuals have been observed to feed while clustered. Just before or subsequent to moulting, the nymphs become active, scatter more or less and begin to feed. The nymphs, like the adults, greatly prefer the tender growing shoot and especially the developing fruit as food.

Second Instar.—The mature form in this instar is about ⅛ of an inch in length and nearly 1/12 of an inch in width. The head and thorax are black, the latter with two yellow spots on either side near the outer edge. The abdomen is reddish black with a number of light spots which are either whitish or light yellow. The eight semicircular spots on either side of the abdomen, one on a segment, are black. The body beneath is black, the abdomen becoming reddish with the tip black. Some color spots, corresponding to those on dorsal surface, are also present. The legs and beak are entirely black. The antennae are black, except for red areas between the second, third and fourth segments.

Third Instar.—In the third instar the shape and color pattern is much the same as in the previous instar. Sometimes, however, the black may be mostly replaced by olive green. The mature form is slightly variable in size, being about 1/7 inch in length and 1/10 inch in width.

Fourth Instar.—The general form and shape in this instar does not differ from the preceding, except that there is a greater variation in the size of different individuals. The average form is about ¼ inch in length and slightly more than 1/6 inch in width. In the fourth and fifth instars there are two color forms, the light color form and the dark color form. There are, of course, intermediate color forms that connect up the light and dark forms.

Light color form: The head and thorax are pale green with a few scattered black dots and black markings and black outer margins. The pro- and mesothorax have orange-colored areas on each side. The eyes are black. The abdomen is a shade darker green than the head and thorax, darkest around salmon-colored areas. A row of two or three spots on median line, a row of five spots on each side of median line, and another row of six spots on either side close to the connexivum are white. The salmon-colored areas, two on median line and six near either outer margin on connexivum, are bordered with black. Head and thorax are pale green beneath, bordered with black, the thorax with black dots and lines and with an orange-colored space near the inner border. The last two segments of the beak and the tibiae and tarsi of the legs are fuscous. The first segment of the antennae is mostly light green and the others fuscous.

Dark color form: The general color is dark brown to nearly black. The white spots on the abdomen are about the same as in the light form, but the salmon-colored areas are wanting. The thorax contains two yellowish areas, one on pro- and the other on mesothorax; each side of thorax and the latteral lobes of the head are sometimes yellowish. The legs, antennae and beak are greenish black. The body beneath is greenish black, the abdomen yellowish tinged with red and margined with greenish black. The thorax has light yellowish areas on both the pro- and mesothorax and the abdomen has a row of five greenish black spots on the median line.

Fifth Instar.—The shape in this instar is about the same as in the others, but the wing pads are now quite conspicuous and cover the basal portion of the abdomen. The size is quite variable in different specimens, the average individual being about 2/5 of an inch long and ¼ of an inch wide.

Light color form (Fig. 18): The head, thorax and wing pads are pale green with black borders on the sides, a few black dots and other markings. The abdomen is pale yellowish green with the rose-colored spots on median line and connexivum black-bordered. The other spots are yellowish white and not so prominent as in the preceding instar. The body beneath is

about the same as in the light colored form in fourth instar, the abdomen differing in having a rose-colored area along the outer black border.

Dark color form (Fig. 18): The dorsal surface of the thorax is usually a little darker than indicated in the figure. The general color is dark brown to nearly black, the abdomen becoming darker. The lateral lobes of the head are orange-colored and there are also orange-colored areas on the thorax. The rose-colored area and white-colored spots on the abdomen are about the same as in light colored form. The head and thorax beneath are olive green with black markings, the latter having also orange areas. The abdomen beneath is light yellow somewhat tinged with red and margined with black. There is a row of four greenish black spots along the median line and rose-colored areas, corresponding to those on the dorsal surface, of the connexivum. The legs are olive green, becoming darker to black towards the tips.

Length of Instars

Table 1.—Table 1 is based on individuals reared in separate breeding cages in the insectary. The food consisted of green tomatoes and pods of radishes and cowpeas. The cages were placed on a table just out of the direct rays of the sun and the food changed every two or three days. The cages were examined and records taken twice a day, about 8 o'clock in the morning and 5 o'clock in the afternoon. The temperature, moisture, sunlight and food supply were as near alike in each cage as could be obtained in a laboratory without control apparatus. The records of different individuals in either lot A or lot B will indubitably prove that it is not safe to assume that an individual, which moults first from a single egg cluster, will continue to moult first in succeeding instars until it reaches the adult state. All nymphs from any one egg cluster usually spend the same or about the same amount of time in the first and second instars, but the period of time for the other instars is quite variable.

In lot B of Table 1 two specimens (cages number 8a and 9a) passed the egg and nymphal instars in 28 days. This was the minimum record for the summer. In the same lot another individual (lot B, cage number 2a) required 48 days to pass through the same stages under similar conditions.

The minimum time for the different instars, when based on different individuals in table 1, is as follows: 1st instar—3 days; 2nd instar—3 days; 3rd instar—1 day; 4th instar—4 days; 5th instar—3 days. This gives a total of only 14 days for the nymphal stages, but, as this is based on several individuals, it probably does not hold true for one individual. 24 days is the minimum time secured for one nymph to pass the five instars (from the same table). The period for the different instars is much lengthened during cool weather of spring and fall.

TABLE 1.—LENGTH OF INSTARS OF NEZARA VIRIDULA BASED ON INDIVIDUALS REARED IN SEPARATE BREEDING CAGES.

Lot A (all from one egg cluster).

Cage No.	Eggs		Period of Incubation	Date of Moulting and Number of Days in Different Instars										Total No. of Days from Egg to Adult
				First		Second		Third		Fourth		Fifth		
	Laid	Hatched		Moult	Instar	Moult	Instar	Moult	Instar	Moult	Instar	Moult	Instar	
1	May 20	May 25	5 days	May 28	3 days	June 3	6 days	June 5	2 days	June 13	8 days	June 26	13 days	37 days
2	May 20	May 25	5 days	May 28	3 days	June 3	6 days	June 6	3 days	June 14	8 days	June 23	9 days	34 days
3	May 20	May 25	5 days	May 28	3 days	June 3	6 days	June 8	5 days	June 17	9 days	June 23	6 days	34 days
4	May 20	May 25	5 days	May 28	3 days	June 4	7 days	June 5	1* day	June 15	10 days	June 22	7 days	33 days
5	May 20	May 25	5 days	May 28	3 days	June 4	7 days	June 1	3 days	June 19	12 days	June 30	11 days	41 days
6	May 20	May 25	5 days	May 28	3 days	June 4	7 days	June 9	5 days	June 15	6 days	June 22	7 days	33 days
7	May 20	May 25	5 days	May 28	3 days	June 3	6 days	June 9	6 days	June 17	8 days	June 26	9 days	37 days
8	May 20	May 25	5 days	May 28	3 days	June 4	7 days	June 15	11 days	June 19	4 days	June 30	11 days	41 days
9	May 20	May 25	5 days	May 28	3 days	June 1	4 days	June 6	5 days	Died				
10	May 20	May 25	5 days	May 28	3 days	June 3	6 days	June 5	2 days	June 13	8 days	June 26	13 days	37 days

Lot B (all from one egg cluster).

1a	May 31	June 4	4 days	June 7	3 days	June 17	10 days	June 24	7 days	June 30	6 days	July 7	7 days	37 days
2a	May 31	June 4	4 days	June 7	3 days	June 17	10 days	June 24	7 days	June 29	5 days	July 18	19 days	48 days
3a	May 31	June 4	4 days	June 7	3 days	June 16	9 days	June 21	5 days	June 26	5 days	July 6	10 days	36 days
4a	May 31	June 4	4 days	June 7	3 days	June 16	9 days	June 21	5 days	June 28	7 days	July 7	9 days	37 days
5a	May 31	June 4	4 days	June 7	3 days	June 20	13 days	June 26	6 days	July 5	9 days	Died		
6a	May 31	June 4	4 days	June 7	3 days	June 13	6 days	June 20	7 days	June 26	6 days	July 12	16 days	42 days
7a	May 31	June 4	4 days	June 7	3 days	June 12	5 days	June 17	5 days	June 24	7 days	July 2	8 days	32 days
8a	May 31	June 4	4 days	June 7	3 days	June 11	4 days	June 15	4 days	June 22	7 days	June 28	6 days	28 days
9a	May 31	June 4	4 days	June 7	3 days	June 15	8 days	June 17	2 days	June 21	4 days	June 28	7 days	28 days
10a	May 31	June 4	4 days	June 7	3 days	June 18	11 days	June 29	11 days	Died				
11a	May 31	June 4	4 days	June 7	3 days	June 11	4 days	June 17	6 days	June 26	9 days	June 29	3 days	29 days
12a	May 31	June 4	4 days	June 7	3 days	June 10	3 days	June 18	8 days	Died				

*This nymph moulted in the morning of June 4th and in the afternoon of June 5th, giving about 30 hours for the third instar.

CONTROL

Natural Enemies

Many natural enemies prey upon the southern green stink-bug and often assist in keeping down the great numbers of this pest. These enemies are represented by parasites on both the adults and the eggs, by predaceous insects and by some insectivorous birds.

Parasites

The most important natural enemies are the dipterous, or two-winged, parasites on the adults. The larvae or maggots of these dipterous insects, or flies, live inside of the host during their development. Here each maggot feeds upon the tissues of the host, usually avoiding the destruction of the vital organs until it is fully matured. Then the full-grown maggot works its way out of the old carcass of its host, in all cases observed at the posterior end of the body or anal opening, and seeks shelter a little beneath the surface of the ground. In about an hour or so the outer skin of the maggot hardens into a brown case, inside of which it changes into a pupa. (The pupa is the resting or transformation state in which many insects undergo that wonderful change from larva to adult). In a few days the pupa changes into an adult fly which breaks through the brown case, or puparium, and emerges. The breeding of many dipterous parasites is quite rapid and, in the species discussed herein, there are several generations in a year.

Several hundred nymphs in each of the five different instars were collected in the field and reared in cages in the laboratory. Only a few nymphs in the fifth instar bore tachinid eggs, but no parasites were bred from these or other nymphs nor from adults which had been reared from nymphs collected in the field.

The eggs are also parasitized by small hymenopterous insects or four-winged flies.

A number of years ago adults of the southern green stink-bug, which had been killed by parasites, were reported by Franklin from Apopka, Florida, in Hubbard (1885, p. 162) who states: "The green bug has a parasite. I do not know what, but I frequently find their shells with the insides devoured out. * * *" Several years later, Morrill (1910, p. 83) states "Of 39 specimens collected by Mr. Hooker at Quincy, Fla., in stages susceptible to parasitism by tachinids, in only one instance was a tachinid egg found attached to a bug. This bug was in the fifth nymphal

instar and became adult 4 days after the egg was first observed and died 10 days later, but upon dissection no evidence of the presence of an internal parasite could be found."

Family Tachinidae

Trichopoda pennipes Fabricius (Fig. 25)

This dipterous parasite was first reported by Watson (1918, p. 261) and a month later by Jones (1918, p. 22) as a common parasite on the southern green stink-bug, *Nezara viridula*. It is probably the internal parasite that had preyed upon the adults noted by Franklin in Hubbard, also which had laid the eggs noted by Morrill.

Fig. 23.—Mature maggot of tachinid parasite (*Trichopoda pennipes*). Greatly enlarged. (Photo by author.)

Undoubtedly, this tachinid fly is by far the most important enemy of the southern green stink-bug in Florida. From 10 to 80 per cent of the adults taken in the field during the summer of 1918 at Gainesville bore tachinid eggs. 800 adults, collected on radish, collard, cowpea and rattlebox during the latter part of May, June and July, were brought in from the field and placed in breeding cages in the laboratory. 38 per cent of these specimens were killed by internal parasites, and of these 31 per cent by *Trichopoda pennipes* (Figs. 23, 24 and 25). In a few cases eggs of this parasite were noted on nymphs in the fourth and fifth instars, but no parasites were reared from these nymphs. However, a few parasites were bred from adults collected in the field that bore no tachinid egg-shells, but it was impossible to determine whether the egg-shells had been dislodged before the insects were captured or whether they had been cast off with the last nymphal skin in moulting. There seems to be no reason why the larger nymphs should not be sus-

ceptible to parasitism; provided the eggs of the parasite are deposited in time to hatch and for the larvae to penetrate the body of the host before the nymphal skin is cast off during moulting.

This tachinid fly is also a parasite on many other large plant-feeding bugs. Specimens have been bred from the common squash bug, *Anasa tristis*, in New Hampshire by Weed and Conradi (1902, p. 20). Chittenden (1902, p. 25) reared it from the northern leaf-footed plant bug, *Leptoglossus oppositus* (Say). Both of these plant-feeding insects are not uncommon in Florida. In addition to the southern green stink-bug the author bred it from the following insects in Florida: The green soldier-bug, *Acrosternum* (*Nezara*) *hilaris* (Say), Gainesville, July 26 and August 10; the green stink-bug, *Acrosternum pennsylvanicum* (DeG.), Fort Myers, August 8; the squash bug, *Anasa tristis* (DeG.), Gainesville, July 20; the banded leaf-footed plant-bug, *Leptoglossus phyllopus* (Linn.) Fig. 34, Gainesville, July 15, and a large coreid, *Archimerus calcarator* (Fabr.), Homestead, July 18.

Fig. 24.—(*a*) Adult tachinid fly (*Trichopoda pennipes*) escaping from pupa case; (*b*) empty pupa case or puparium.

Quite frequently during July and August the adults of the banded leaf-footed plant-bug, *Leptoglossus phyllopus* (Fig. 34) were noticed with the eggs of this tachinid fly attached to their thorax and other parts of their body. These specimens were feeding on cowpeas that were badly infested by the southern green stink-bug. During the first week in August the eggs of this parasite were also noted on two species of the large big-footed plant bugs, *Acanthocephala femorata* (Fabr.) and *Acanthocephala declivis* (Say).

Notes on the Life History of the Parasite

The Adults.—Both the male and the female of *Trichopoda pennipes* (Fig. 25: a, male; b, female) are somewhat variable in

size, ranging from about 1/3 to ½ inch in length. The general color is black with a yellowish or reddish-yellow abdomen. The thorax in front is beautifully marked with alternating lines of black and golden yellow. In some specimens the color markings on the thorax are not very distinct. The front of the head is whitish with a golden yellow stripe adjacent to the inner side of each eye. The sexes are readily distinguished by color markings.

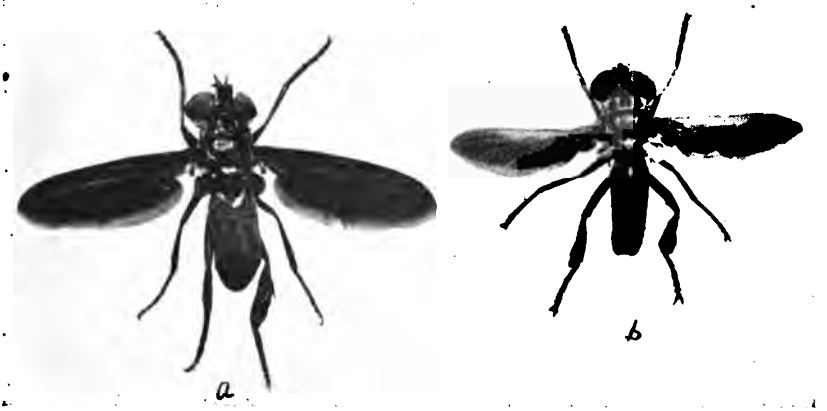

Fig. 25.—(*a*) Adult male and (*b*) female tachinid fly (*Trichopoda pennipes*). Enlarged (Photo by author).

In the male the tip of the abdomen is black and the wings are entirely black. The abdomen of the female is entirely yellowish or reddish-yellow and the wings are margined with yellowish on about one-half of the basal portion of the anterior margin. The legs are black, except a yellow basal portion, in both sexes.

This parasite is a nectar loving insect and both males and females are attracted to the blossoms of several wild plants. On bright sunny days they may be seen flying among the flowers and searching for the nectaries. Numerous specimens have been collected by the writer at Gainesville, Florida, on the flowers of the following plants: Chinquapin, *Castanea pumila* (L) Mill., a few specimens during the first and second weeks in May; basswood or linden, *Tilia americana* L., a few specimens during June; rattle-box, *Crotalaria usaramoensis* (Fig. 36), very common during July, August and September; Angelica tree, *Aralia spinosa* L., numerous specimens during July and August; pepper-vine, *Cissus (Ampelopsis) arborea* (L) thoroughwort, *Eupatorium* sp., common during October and November (Watson).

The blossoms of rattle-box, *Crotalaria usaramoensis*, seem to exert the greatest attraction to this parasite and many specimens were noted visiting the flowers during July, August, and September. A number of the parasites were captured while they were visiting the bloom of rattle-box, and the contents of their digestive organs studied in the laboratory. In some specimens the entire alimentary canal was removed and the contents studied by means of the compound microscope. In other specimens the

Fig. 26.—Adult sarcophagid parasite (*Sarcophaga sternodontis*). Much enlarged. (Photo by author).

contents of the digestive organs were washed out in water and tested for sugar by means of Fehling's solution. No pollen grains were observed under the microscope, but Fehling's solution showed the presence of sugar. The contents of the alimentary canal were not studied for other flowers.

Distribution.—This parasite, no doubt, occurs throughout the entire state of Florida. Johnson records the species from St. Augustine, Georgiana (July), Lakeland (May 6) and Charlotte Harbor (January and April.) The author bred many

specimens from insects at Gainesville, also from specimens sent in from Fort Myers and Homestead. According to the records cited by Aldrich (1905, p. 425) this Tachinid fly occurs in the West Indies, Mexico, and Eastern United States (Grinsby, Canada to Florida; Florida to southern California).

During copulation both sexes face in the same direction, the male being uppermost. The process closely resembles that of the ordinary house-fly. Mating usually takes place while the pair is resting on some foliage, but in one instance a pair was observed on the wing with both sexes actively flying (hovering) near the flowers of rattle-box. The period of duration, as timed in the breeding cages, was found to vary from about one to twelve minutes. Observations show that coition is repeated several times, even during the egg-laying period.

Fig. 27.—The Florida predaceous bug *(Euthyrhynchus floridanus)*. Enlarged. (Photo by author.)

The egg (Fig. 21) is ellipsoidal in form, the attached side being flat and the opposite strongly convex. The outer surface is glistening and minutely sculptured with traces of hexagonal markings. It is about 1/45 inch in length and 1/70 inch in width. At the time of deposition, the egg is whitish in color, but it soon changes to a darker or grayish hue. A gluey liquid accompanies the egg which quickly hardens in the air and firmly glues the egg to the body of the host. The eggs are laid singly, only one egg being placed at a time on the host. However, there seems to be no discrimination as to where the egg is placed on the body; and a female will not hesitate to deposit an egg on a bug that already bears one or more tachinid eggs. Most of the adults in the field bore only one tachinid egg, but it was not uncommon to find two, three, four or even five eggs on a single individual. Where the flies were rather numerous, I have found as many as eight eggs upon a single host.

The number of eggs on a bug seems to depend largely upon the number of times a female tachinid fly, either the same female

or other females, happen to come in contact with the body of the bug. This was nicely illustrated in the breeding cages. On July 15 a pair of tachinids was placed in a breeding cage containing twelve reared adults of *Nezara viridula*. During the afternoon the female deposited eggs as follows: No eggs on two bugs, one on two, three on one, four on two, and five on two. Both male and female died during the following night; upon dissection 17 eggs in various stages of development were found within the body of the female. Although this gives a total of 46 eggs; it probably does not represent the entire number of eggs laid by this female as she may have deposited several eggs before the pair was collected in the field (62 eggs have been found in the body of a single female that was taken in the field while depositing eggs). In other breeding cages several pairs of *Trichopoda pennipes* were confined with numerous reared specimens of the southern green stink-bug. In all cases the tachinid flies were taken while copulating in the field. In depositing an egg the female tachinid, as she crawls over a bug, quickly lowers the tip of her abdomen and places an egg on the bug. The bugs seem to pay no attention to the tachinids. In fact their presence does not seem to disturb or annoy them at all. In one cage 22 eggs were deposited on a single specimen of *Nezara viridula* (Fig. 21), 16 being on the dorsal surface of the body. In the field and in the breeding cages eggs have been deposited upon the eyes, legs, head, thorax, wings, abdomen, and ventral surface of the body of the host. The location of the egg seems to depend upon where the female parasite chances to pass over the host. Neither the female tachinid nor the host pays any attention to the eggs after they have been deposited.

Fig. 28.—The predaceous wheel-bug (*Arilus cristatus*). Enlarged. (Photo by author.)

Upon hatching the minute young maggot makes a very small hole through the flat or attached side of the egg into the host. In figure 22 the egg shell has been removed to show the hole through the exoskeleton made by the tiny maggot in entering the

host. This hole is greatly enlarged in the picture. No other hole or opening, except one through the attached side of egg-shell, is made by the maggot in escaping from the egg. The maggot or larva lives, feeds and grows on the inside of the host until it is full-grown. The mature maggot then works its way out of the body of the host at the posterior end of the abdomen and buries itself in the ground. The host dies a little before or soon after the mature maggot leaves its body. The incubation of the egg and the development of the maggot within the body of the host required from 17 to 24 days. Eggs have been observed to hatch in two or three days. Eggs of this tachinid fly have been observed on *Nezara viridula* during the months of April, May, June, July, August, September, October, November and December. The adult flies have also been seen in the field during these months and March at Gainesville. No records have been made during the other months.

Fig. 29.—The spined soldier-bug (*Podisus maculiventris*) killing a beetle. Enlarged. (Photo by author).

The mature larva or maggot (Fig. 23) is light yellowish white in color and varies from about ⅜ to ½ inch in length. After descending into the soil the maggot prepares for the transformation into the winged fly. It contracts slightly, assumes a regular ovoid shape, and forms a pupacase or puparium in a very short time. When placed in a glass vessel and forced to pupate under aerial condition, the larva would crawl about for a time seeking suitable conditions to pupate. However, after crawling about for an hour or two the larva will transform to the pupa state in the open. The puparium or pupa-case is nearly smooth, ovoid in outline, brown in color and a little shorter than the mature maggot. Within the pupa-case or puparium many complicated

changes take place during which legs, wings, eyes, hairs, mouth-parts, and other structures of a winged fly slowly make their appearance. The pupa stage lasts from eleven to thirteen days, twelve days being the average time. When fully formed, the mature tachinid fly (Fig. 25) by means of dilations of its face, pushes off the lid-like portion of the anterior end of the puparium (Fig. 24) and in a similar manner works its way up through the soil. In about a half hour or a little longer the body is entirely hardened, the wings fully expanded, and the color markings fixed to that of the adult. It is rather interesting to note that the

Fig. 30.—The harlequin cabbage-bug (*Murgantia histrionica*) feeding on collard leaf. Note large whitish areas caused by feeding. Slightly enlarged. (Photo by author).

emergence of this parasite as well as that of the other dipterous parasites generally took place in the morning, principally between eight and ten o'clock.

Only one mature maggot of *Trichopoda pennipes* (Fig. 23) was bred from a single host, even when the host bore a number of the eggs of the parasite.

Trichopoda lanipes Fabricius

Only one example of this tachinid fly was reared during the summer. It was bred on August 8th from a specimen of the southern green stink-bug, *Nezara viridula*, that had been sent in from Fort Myers, Florida. The species can readily be separated from *Trichopoda pennipes* by its entirely black legs and abdomen.

This tachinid fly is rather common in the vicinity of Gainesville and it is also attracted to the blossoms of wild flowers. Prof. P. W. Fattig and the author captured a few specimens while they were flying among the flowers of the angelica-tree, *Aralia spinosa*

Fig. 31.—Lateral view of the eggs of the harlequin cabbage-bug (*Murgantia histrionica*). Greatly enlarged. (Photo by author).

L., and the pepper-vine, *Cissus arborea*, during the latter part of July and August. Prof. Watson collected it on basswood blooms in May. No specimens were reared from insects collected at Gainesville.

Family Sarcophagidae

Sarcophaga sternodontis Townsend (Fig. 26)

In general appearance and size this two-winged parasite very much resembles the omnipresent house-fly. It ranks next to the tachinid fly, *Trichopoda pennipes* (Fig. 25), as a natural enemy of the southern green stink-bug, about six per cent of the adults being killed by this parasite at Gainesville. As in the other parasites, the larva or maggot lives within the body of the host and feeds upon the internal tissues of the host throughout its development. When fully matured, the maggot crawls out of the posterior end of the abdomen and seeks shelter a little beneath the surface of the ground to pupate. Usually, only one maggot lives within the body of the southern green stink-bug, but in a few cases two maggots were reared from one specimen. In larger insects a number of maggots often live within the body of the same host at the same time, three being reared from one

specimen of a large coreid (Fig. 33), *Corecoris confluenta* (Say), in the last nymphal instar and twenty-six from four specimens of the large lubber-grasshopper. When two or more maggots live within the body of one host, they mature at the same time; this seems to indicate that they are practically of the same age.

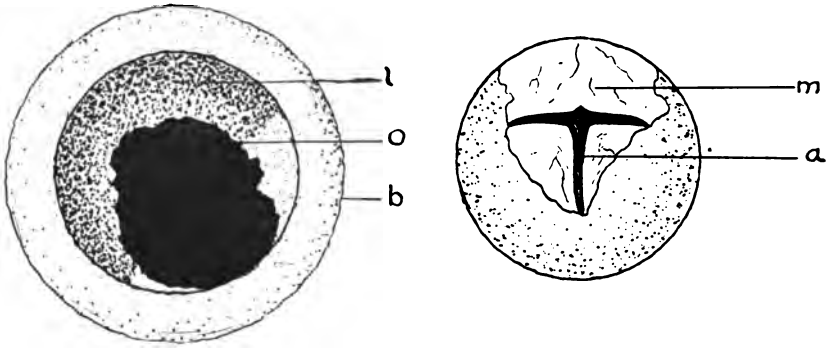

Fig. 32.—Dorsal aspect of eggs of harlequin cabbage-bug: *l*, lid, or cap; *b*, outer wall or barrel of egg-shell; *o*, opening made by egg-parasite through lid in escaping from egg-shell; *a*, egg-burster used by nymph in opening lid of egg-shell; *m*, membrane. (Drawn by Wessel.)

The full-grown maggots usually leave the body after the death of the host, the time varying from one to six days. Occasionally, a mature maggot has been observed to crawl out of the posterior end of the abdomen a few hours before the death of the host. The full-grown maggot is dirty grayish white in color and about three-eighths of an inch in length. The pupa case or puparium is a little shorter than the mature larva, nearly smooth, reddish brown in color, and ovoid in form. The pupa state lasts from seven to ten days, eight days being the average time. When fully formed, the adult fly, by inflating the ptilinum, pushes open, or off, a lid-like portion of the anterior end of the puparium, works its way out of the opening thus formed, and then up through the ground. In a remarkably short time, usually within a half hour, the wings are wholly expanded and the body perfectly indurated.

According to Aldrich (1905, p. 514) this sarcophagid has been bred from a cerambycid beetle, *Sternodontis damicornis*, and from a scorpion, *Centurus edwardsii*, in Jamaica, West Indies. In Florida, Aldrich (1916, p. 267) states that it has been reared from the American locust, *Schistocerca americana;* the large lubber-grasshopper, *Dictyophorus reticulatus;* and the larva (hickory horned devil) of the regal moth, *Citheronia regalis*. In addition to the many records of specimens bred from

the southern green stink-bug, the author has reared the parasite from the following insects in Florida: The northern green soldier-bug, *Acrosternum hilaris* (Say), 3 specimens, Gainesville, June 10; the harlequin cabbage-bug, *Murgantia histrionica* (Hahn) (Fig. 30), 5 specimens, Gainesville, June 20 and 21; the brown stink-bug, *Euschistus servus* (Say), 6 specimens, Bulow, June 12 and 1 specimen, Gainesville, June 27; a very large coreid, *Corecoris confluentus* (Say) (Fig. 33), 4 specimens from two nymphs, Homestead, July 26, and the large lubber-grasshopper, *Dictyophorus reticulatus* (Thumb), 26 larvae from 4 adults, Putleta, July 28.

Other Dipterous Records

One specimen of *Muscina stabulans* Thumb (family Muscidae) and several specimens of *Fannia femorata* Lw. (family Anthomyiidae) were reared from several dead specimens of the southern green stink-bug on June 15. My records seem to indicate that both of these flies are scavengers instead of parasites. The cover of the glass breeding cage had been accidentally removed and it seems that in all probability the specimens became infested after death. No examples of either of these species were bred from other breeding cages or living hosts. A little humpbacked fly, *Phora scalaris* Loew, was found breeding in dead specimens which had been placed in waste jars; it was also noted breeding in decaying vegetation.

Fig. 33.—A large plant-feeding bug (*Coreocoris confluentus*). Slightly enlarged. (Photo by author).

Egg Parasites

Occasionally, the eggs of the southern green stink-bug are parasitized by minute four-winged insects that are commonly known as chalcid flies. They belong to the superfamily Chalcidoidea of the order Hymenoptera.

The female egg-parasite, with the aid of her ovipositors, makes a tiny hole through the shell of an egg (host) and then, through the opening or hole thus formed, places one of her own eggs on the inside. Here her egg hatches and the young maggot-like

larva, feeding upon the contents of the egg, lives and grows until it is fully matured. Pupation also takes place within the egg-shell. In a very short time a minute four-winged fly is formed within the pupa case. This fly works its way out and escapes from the egg or host by eating an irregularly-shaped hole thru the cap or disc-shaped lid (Fig. 16). In all cases observed the mature egg-parasites emerge after the non-parasitized eggs have hatched.

Fig. 34.—The banded leaf-footed plant-bug (*Leptoglossus phyllopus*). Enlarged. (Photo by author).

During the last two weeks in May and the first week in June, 40 egg clusters of the southern green stink-bug were removed from the leaves of radish and collard in the field and placed in small, low stender dishes with ground glass covers. In most cases a small portion of the leaf was removed with the egg cluster so as not to injure or destroy any of the eggs. The eggs were in various stages of development, many of the clusters being almost ready to hatch. These 40 clusters contained 3544 eggs, averaging a little better than 88 eggs to a cluster. 3 mature parasites were reared from these eggs and 581 of them failed to hatch or over 16 per cent of the total number of eggs failed to develop. Of the 581 eggs, most of them seemed to be unfertile, a few contained parasites that failed to escape, and several contained nymphs that died just before hatching. On the other hand, some of the eggs may have been destroyed under the artificial conditions in the insectary. However, it was not at all uncommon to find several eggs in a cluster that had failed to develop outdoors under natural conditions. The 3 mature parasites were determined by Mr. Gahan of the United States Department of Agriculture as a new species belonging to the genus *Ooencyrtus* of the family *Encyrtidae.*

Many other egg clusters were incubated in the insectary or examined in the field after hatching, during the summer, and only two others showed evidences of egg-parasites. A cluster of 95 eggs, found on the underside of a cowpea leaf, about the middle of July, a few days after hatching contained four eggs with the

characteristic hole or opening (Fig. 16) of the parasites in the lid and 14 eggs that had failed to incubate. The other egg cluster was removed from the underside of a leaf of rattle-box (Crotalaria) a few days after deposition and the incubation period completed in the insectary. Out of the 99 eggs in this cluster, 12 mature parasites were reared and the rest of the eggs were all fertile and hatched perfectly. As these 12 egg-parasites were all males, Mr. Gahan states that it is impossible to give even a generic name for them, but that they belong to the Chalcidoid subfamily Eupelminae.

Fig. 35.—Eggs of the brown plant-feeding stink-bug (*Euschistus servus*) on an orange leaf. Greatly enlarged. (Photo by author).

According to Morrill (1910, p. 82) and Whitmarsh (1917, p. 542) the eggs of the northern green soldier-bug, *Acrosternum hilaris,* are frequently parasitized by a proctotrypid parasite. To quote from Whitmarsh: "These small black fly-like parasites

are most noticeable in mid-July, or at the time when the pentatomids are at the height of the egg-laying season." This egg-parasite was determined by Girault as belonging to the genus

Fig. 36.—A trap and propagating plant (*Crotalaria urasamoensis*). The plant attracts the southern green stink-bug (*Nezara viridula*) and the blossoms attract the most important parasite (*Trichopoda pennipes*). On station grounds at Gainesville. (Photo by Thompson).

Trissolcus, probably *euschisti* Ashmead. Girault (1907, p. 30) lists *Trissolcus euschisti* as an internal parasite upon the eggs of three brown stink-bugs, *Euschistus servus* (Fig. 35), *E. tristigmus* and *E. fissilus* (*euschistoides*). The first two species are very common plant-feeding insects in Florida.

Fig. 37.—Radish plants bearing pods. Radish and collard make a good trap crop to protect tomatoes. (Photo by author).

During the months of July and August the author found that from five to ten per cent of the eggs (Fig. 31) of the harlequin cabbage-bug were destroyed by two internal parasites, *Trissolcus murgantiae* Ashmead and *Ooencyrtus johnsoni* Howard. The eggs of the southern green stink-bug, when removed from the same plant (collard) or plants growing in the same patch, failed to show any evidences of either of these parasites.

Trissolcus podisi has also been reared from the eggs of the Harlequin cabbage-bug by Morgan in Louisiana and Mississippi.

Identification of Parasites

The reared parasites or mature forms were turned over to specialists for identification. At this opportunity the writer wishes to express his appreciation to Prof. Jas. S. Hine, Ohio State University, Columbus, Ohio, for the determination of the Diptera. The Sarcophagidae were forwarded by Prof. Hine to

Dr. J. M. Aldrich, National Museum, Washington, D. C., for identification. Through the courtesy of Dr. L. O. Howard, Mr. A. B. Gahan has very kindly determined the egg-parasites.

Predaceous Insects

Several predaceous insects prey upon the southern green stink-bug in Florida. These consist of two predatory pentatomids, three assassin-bugs or reduviids and one large wasp.

Euthyrhynchus floridanus (Linn.), the Florida predaceous bug (Fig. 27).

This is the most important predatory enemy of the southern green stink-bug, numerous records being made by the writer during May, June, July and August in the field. In most cases the predator had impaled a mature victim on its beak, the beak usually penetrating the dorsal portion of the thorax. The Florida predaceous bug is also an important enemy of many other plant-feeding insects, including the velvet bean caterpillar, and should not be destroyed.

Podisus maculiventris (Say), the spined soldier-bug (Fig. 29).

Altho very common in the fields, only two instances of this insect feeding upon the larger nymphs of *N. viridula* were noted. Jones (1918, p. 22) found it preying upon a nymph in the fifth instar in Louisiana.

Arilus cristatus (Linn.), the wheel-bug (Fig. 28).

This is another insect that preys on the southern green stink-bug. Two large nymphs of the wheel-bug were found feeding upon specimens of *N. viridula* in the fourth and fifth nymphal instars during the latter part of May. The wheel-bug is so called because of a prominent, semicircular, toothed ridge on its thorax which greatly resembles a half cogwheel.

Sinea spinipes (H. S.) and *Zelus cervicalis* Stal., assassin-bugs.

An adult of each of these assassin-bugs was found on *Amaranthus* sp. with its beak piercing the body of a nymph in the second instar.

Bicytes quadrifasciata Say, a large bembecid wasp.

According to Jones (1918, p. 23) "Mr. S. A. Rohwer of the Bureau of Entomology states that a bembecid wasp which Mr. Russell collected at St. Leo, Fla., October 22, 1907, belongs to this species. The specimen was taken while in flight with an adult of *Nezara viridula* in its mandibles."

Birds

The food habits and stomach contents of many American birds have been carefully studied by the United States Biological Survey and others to determine their economic status in various parts of the country. The malodorous bugs, including the ill-flavored and strong-scented stink-bugs, have been found to constitute a part of the food of a number of birds. Among these birds might be mentioned the quail, the blackbird, the crow, the swallows, the flycatchers, the thrushes, the robin, etc. The northern green soldier-bug, *Acrosternum hilaris* has been found in the stomach of the quail, the robin, the cliff-swallow, the crested flycatcher and other birds. In Porto Rico, Wetmore found *Nezara* sp. in the stomach of a number of different birds. Numerous similar records have also been published for the United States.

In regard to the southern green stink-bug, *Nezara viridula*, Watson (1918b, p. 232) states "In spite of the bad smell birds occasionally eat these bugs." Chickens have also been noted by Watson (1918c, p. 90) as feeding upon this pest. During July, the writer placed a number of nymphs on the twigs of young orange trees. On the following morning a number of these twigs were without insects, probably being destroyed by birds.

A letter from Prof. Watson (Dec. 1919) states that he finds that mature chickens are very fond of the southern green stink-bug, especially after they are taught to eat them. This can readily be done by throwing a few stink-bugs to a flock of chickens which are confined. If chickens are allowed to run through a field they can be depended upon to keep the bugs down, particularly in the late fall when the bugs are usually more troublesome. Of course chickens are a nuisance in a truck patch and this remedy will have to be conducted with some discretion. This is accomplished by giving the chickens all the green stuff they will eat before turning them loose in the garden, and then only for an hour or two before roosting time so that they will not have much time to wallow. Where young chickens can be allowed to run over the garden and the old hen confined, it is much more satisfactory from the standpoint of growing vegetables. Take a coop full of chickens and move them, old hen and all, to the center of the infested area, open the coop leaving out the chickens, but keeping the old hen confined. However, the young chickens have

to be of fairly good size before they will be very efficient catchers of the adult insects.

Climate

Climate is often considered an important factor in the control of economic insects. In Louisiana, Jones (1918, p. 23) found that specimens of the southern green stink-bug, especially nymphs, are sometimes killed by low temperatures during the winter months in the insectary; he also states that a sudden drop in temperature during this season of the year often kills individuals in the field and gives specific cases for Florida and Texas. At Gainesville, Prof. Watson states that he has never seen many adults that were killed by cold weather, but, although they sometimes find dead specimens during the winter, a careful examination of their bodies generally shows signs of parasitism. He believes that the disappearance of this insect during the winter months is due largely to stoppage of breeding, to work of parasites and to hibernation. Of course, there is undoubtedly a natural mortality (probably higher) during winter as in other seasons of the year. About one-half of the individuals seek favorable places to hibernate during cold weather and this probably accounts for the paucity of numbers often noted by growers during the winter, especially in the central and northern parts of the state.

On the whole it seems that the bioclimatic factors, as climate, weather, sunshine, topography, latitude, altitude, etc., have been well suited for the propagation and dissemination of the insect in Florida. The mild winters do not, at least, kill great numbers of the pest and it is not uncommon for serious outbreaks during early spring and summer upon cultivated plants, especially tomatoes, potatoes, beans, peas, etc.

Artificial Control

Clean Culture

There are a number of wild plants or weeds upon which the insect feeds and breeds, especially during early spring and late fall. Volunteer plants should also be classified as weeds. The preferred food plants, both wild and cultivated, belong largely to the legumes or Pulse family (Leguminosae) and to the mustard family (Cruciferae). The individuals that do not seek favorable places to hibernate during cold weather generally remain upon some member of the mustard family throughout the

entire winter. Weeds and volunteer cultivated plants should be kept down at all times, not only in cultivated field, but in other fields and waste places. The destruction of these plants will keep down the food supply, kill many immature forms and shorten the breeding season. The remnants of field, truck, garden and cover or soiling crops should be scrupulously destroyed after the crop is harvested so as to stop breeding and destroy immature forms.

A leguminous cover or soiling crop, as beggarweed, cowpeas, etc., is generally grown during the summer in both citrus and pecan groves, the crop to be cut or turned under later on. The proper management of this cover crop upon which the insect breeds is a potent factor in controlling the pest upon either citrus or pecan trees. As stated by Watson (1917a, p. 60R) the beggarweed or cover crop should be cut with a scythe in the rows and from around the trees first, leaving the middles between the rows of trees to be cut a few days later, but not later than September 15. The immature forms will then work away from the trees to the uncut legumes, and, when the middles are cut a few days later, most of them will die before they can crawl back to the citrus or pecan trees. The cover crop should never be left to stand until fully matured, either in the entire grove or in the rows with the trees. Mature plants are unattractive to the insect and, as a rule, the insect can be kept down to a large extent by a proper cutting of the cover crop at the right time.

Trap and Decoy Crops

Of the long list of food plants field observations show that the adults prefer and are attracted largely to leguminous and cruciferous plants. To a large extent the preferred food plants can be classified into seasonal food plants, thereby giving the trap or decoy crop to use during the different seasons of the year. The leguminous plants, as cowpeas, beggarweed, rattle-box, beans, etc., are greatly preferred during late spring, summer and early fall; while cruciferous plants, as radish, rape, collard, mustard, turnip, etc., are attacked mostly during early spring and late fall. Adults that do not seek suitable places to hibernate during cold weather usually overwinter on the leaves of cruciferous plants, as Essex rape, radish, collard, mustard, etc., growing in the fields and waste places. No feeding takes place, except during the warmest hours of warm days, in the winter. Radish (Fig. 37) interplanted with collard seems to be the best trap

crop to protect tomatoes. Radish and collard, planted about the first of November, has proven very attractive to the bugs during the tomato season of the following spring; in fact so attractive that tomatoes growing in adjoining rows or the same patch were not or scarcely at all infested. The bugs on the trap crop should be gathered by hand picking during the tomato season and both trap crop and remnants of tomato crop destroyed after the tomatoes are gathered and thus stop further breeding and destroy immature forms.

Leguminous plants are most alluring to the bugs during the pod formation period. Hand picking is undoubtedly the best method to use in gardens and truck patches for the control of the insect upon beans, peas, etc. The proper management and cutting will usually keep the pest under control where leguminous cover or soiling crops are grown. There is, of course, an overlapping of the seasonal food plants, especially during fall and spring.

Rattle-box (Fig. 36), *Crotalaria usaramoensis,* seems to offer the greatest possibilities as a trap crop for summer and fall until killed by frost. Rattle-box, or butcher-rattle, as it is sometimes called, is an herbaceous leguminous plant used in Java, East Indies, for green manuring. Two ounces of seed were received by the United States Department of Agriculture, December 26, 1917, from Buitenzorg, Java. Part of this seed was forwarded to the Experiment Station, Gainesville, Florida, during the latter part of March and planted on the station grounds on April 6, 1918. The plant is unknown to most growers in the state. Through the kindness of Prof. J. B. Thompson, Forage Crop Specialist, the following notes on rattle-box have been turned over to the writer. *Crotalaria usaramoensis* is an erect growing herb measuring from four to six feet in height with a lateral spread of three feet or more. It makes a very dense leafy growth while a profusion of bright yellow, pedicillate flowers borne on long terminal racemes gives it added ornamental value. Flowering plants may be produced in from eight to ten weeks from the seed, which may be planted as early in spring as desired after the dangers of frost are past. As an ornamental plant its value is greatly enhanced by its free blooming habits and a long blooming period that lasts all summer and is only ended by a killing freeze. It would probably succeed in winter in the southern part of the state wherever frost does not occur. This

species is adapted to a wide range of conditions, but will thrive best on light fertile soil; and it delights in a warm location with plenty of sunshine. It is a splendid subject for planting where a quick-growing, temporary, ornamental hedge is desired. It also offers promising possibilities in farm practice for planting as a cover or soiling crop and for soil improvement purposes.

The ever-blooming and the long pod forming period adds greatly to the value of rattle-box as a trap crop. At Gainesville during the past summer (1918) the plants, from seed sown on April 6, began blooming during the early part of June and continued to blossom profusely until killed by a frost on December 28. The plant forms pods and seeds freely during July, August and September, but seeded very little after cool weather set in. Rattle-box is probably not more attractive, if as much so, than cowpeas and beggarweed, but the period of greatest attractibility to the insect is very much longer than that of other legumes on account of the extremely long period of pod formation. Like other legumes, rattle-box is not especially attractive to the bugs after the fruiting period, especially late fall.

As a trap crop rattle-box serves a twofold purpose. The blossoms exert a special attraction to many flower-visiting insects. Among these flower-visiting insects are numerous dipterous parasites, including the most important parasites of the southern green stink-bug. The tachinid fly, *Trichopoda pennipes* (Fig. 25) is a honey-loving insect and both male and female are much attracted to the blossoms of rattle-box for the nectaries. The long period of inflorescence, blooming continually and profusely from about ten weeks after seed is sown until killed by frost, is much in favor of rattle-box for attracting nectar-feeding parasites. The sarcophagid fly, *Sarcophaga sternodontis* (Fig. 26) and the tachinid fly, *Trichopoda lanipes,* both parasites of the southern green stink-bug, were not uncommon visitors to the flowers of rattle-box. Several other dipterous parasites were also noted.

Rattle-box should be grown as a propagating plant for parasites. The percentage of individuals of the southern green stink-bug that bore tachinid eggs was greater on rattle-box during the pod formation period than that of cowpeas and other leguminous plants during the fruiting season. This is readily explained by the fact that both blossoms and seed-pods are formed continuously during the summer, the blossoms attracting the parasites

and the pods attracting the stink-bugs. The principal parasite, *Trichopoda pennipes* (Fig. 25) could always be found flying among the flowers on warm sunny days favorable to the insects.

Of 161 adult bugs collected on rattle-box, August 10, 1918, by Prof. Thompson and the writer, 110 or a little over 66 per cent bore eggs of the tachinid fly, *Trichopoda pennipes*. On August 12 all bugs were again collected on the same plot (Fig. 36); out of

Fig. 38.—Method of hand collecting on citrus trees. (Photo by Watson).

71 specimens, 57 or slightly more than 80 per cent bore eggs of the same tachinid parasite. The last record was the highest one taken during the summer. Most of these stink-bugs bore only one tachinid egg, but it was not uncommon to find two, three, four or even five on one individual. On account of the high per cent of parasitism the southern green stink-bug should not be collected on rattle-box and destroyed by hand picking. The destruction of the bugs will destroy the parasite. Rattle-box could be

grown in plots as a propagating plant and thus increase the number of parasites.

Hand Collecting

The habit of the insect, when suddenly disturbed or when a limb is jarred, of dropping makes hand collecting profitable where valuable garden and truck crops are infested, also when citrus fruits are attacked. As the bugs are rather sluggish during cool weather, they should be gathered in early morning, or on cool or rainy days. The temperature should not be above 70° F., but a lower temperature, of course, would be much better. On potatoes, tomatoes, beans, peas, etc., the bugs should be brushed or jarred into a wide-mouthed collecting pan (preferably one with a handle) containing about an inch of water covered with a film of kerosene. The egg clusters should also be destroyed.

On citrus trees Watson (1918, p. 233 and 234) has demonstrated that the bugs can be collected economically when they are destroying the fruit or injuring young trees. For collecting the bugs on trees large nets (Fig. 38) of at least three feet in diameter and of about an equal depth were constructed. These nets should be made out of heavy muslin or preferably, good canvas.

"Each net should have a short handle which if extended across the diameter to stiffen the opposite rim will permit the use of telephone wire to complete the skeleton for the net. Bend the wire into a loop and nail the loose ends to a wooden handle.

"One man can manipulate this net, but two may work to better advantage. One places the net under a limb of fruit and the other gives the branch a quick, vigorous shake which causes the bugs to roll into the bottom of the net. After the men have finished a tree the bottom of the net is dipped in a bucket containing kerosene. This keeps the net constantly wet with kerosene.

"The work cost in one grove of ten-year-old trees set 20 by 30 feet between 50 and 75 cents an acre, and from 30 to 100 bugs a tree were collected. Two men with a net covered at least an acre in two hours.

"The labor cost $1.50 a day for each man. This is less than the cost of spraying even if a safe and effective solution were known. On larger trees with more bugs the cost is greater, but should in no case exceed $1.50 an acre,—still much less than the cost of spraying.

"For large trees not too close together and with few limbs touching the ground to prevent a ready manipulation, the nets should be larger. The writer (Watson) has used some nets 6 by 12 feet. These were suspended from a light wooden frame like those used for holding quilts or stretching curtains, the net sagging two or three feet in the center. The net should be of closely woven canvas so that insecticide oil, crude oil or kerosene can be placed in the bottom, into which the bugs will fall. Cotton waste placed in the net will absorb the oil and in rolling around will thoroughly wet the bugs. Two men will be required to manipulate the net and at least another to shake the branches.

"For large trees these nets will be found more economical than the smaller ones strung on telephone wire. They are effective, however, only at a

temperature below 70 degrees. Above that the bugs will take to wing as they drop, before they strike the canvas. The use of the large nets is therefore restricted to the very early morning, to moonlight nights and to cold days. The smaller nets can be used all day, though more effectively in the early morning."

Spraying

Both Watson (1918a, p. R59-R62) and Jones (1918, p. 23-25) have demonstrated that it is not practical to use contact insecticides as a solution strong enough to kill the insect will injure or destroy the plants. Experiments with kerosene emulsion and nicotine sulphate gave negative results. A solution that will not injure the foliage of plants will not destroy all of the younger nymphs and has very little or no effect upon the larger nymphs and adults.

Nymphs and adults are both quickly killed when sprayed with pure kerosene. Badly infested weeds and remnants of cultivated plants should be destroyed, either by cutting or spraying. If the insects are mostly in the adult state, the latter method should be used.

SUMMARY

A large green stink-bug, *Nezara viridula* Linn., often becomes a serious pest upon cultivated plants in Florida. Its depredations are also well known in other southern states, but particularly in the Gulf States. The insect is of foreign origin and is almost universally distributed throughout the tropical and neotropical regions of the entire world. Its ravages have also been reported in Australia, India, West Indies, Austria and other countries.

Both nymphs and adults obtain food by puncturing the tissues of plants and then extracting the plant juices. All parts of plants are attacked, but tender young shoots and maturing fruit are greatly preferred. Among the garden, truck and soiling or cover crops injured, are tomato, Irish potato, sweet potato, beans, cowpeas, beggarweed, radish, collard, cabbage, turnip, mustard, okra, etc. In fall and early winter the insect sometimes becomes a serious pest in citrus groves, feeding especially upon the fruit, young seedlings and young shoots of older trees. Similar infestations have been reported for pecan groves.

Notes on habits and life history studies have been carried on at Gainesville, Florida. Hibernation is imperfect, about one-half of the individuals remaining upon succulent plants in the field throughout the winter months. No breeding takes place during

the winter. Eggs have been found outdoors during the second week of April and as late as December 12. The eggs are deposited in clusters, mostly on the underside of the leaves. Some females deposited no eggs, while others laid one, two or even three egg clusters. One female laid 212 eggs, three clusters of 78, 70 and 64 eggs respectively. No eggs were found in her ovaries at death. 40 egg clusters, collected consecutively in the field, contained 3544 eggs, averaging a little over 88 eggs to a cluster. The clusters were made up of from 46 to 126 eggs.

The minimum period for incubation was 4 days. The minimum time for the five nymphal instars, based on individual records, was 24 days. This gives a total of only 28 days from the time the eggs are laid until the adult state is reached. Field records indicate that there are four generations annually at Gainesville and probably five in the southern portion of the state. Development was more rapid during the summer than either spring or fall, temperature having an important bearing upon the period of development of both eggs and nymphs. Table 1 gives the variation in time for the development of nymphs from two different egg clusters and shows that the first nymph to issue from an egg in a cluster is not always the first to reach the adult state.

Six predaceous enemies have been recorded in the field, the Florida predaceous bug *(Euthyrhynchus floridanus)* being the most important.

Three parasites of the adult and two egg parasites have been reared. Out of 800 adults of *Nazara viridula* collected in the fields during the latter part of May and the first of June, 38 per cent were killed by two dipterous parasites, 31 per cent by the tachinid fly, *Trichopoda pennipes,* and the rest by the sarcophagid fly, *Sarcophaga sternodontis.* Both of these parasites were also bred from a number of other plant-feeding insects in Florida. The egg parasites were not common at Gainesville and are represented by undescribed species.

In most cases parasitized specimens of *Nezara viridula* failed to deposit eggs before they died. In a few instances females, collected in the field, deposited eggs before they died from the effects of parasitism. Breeding experiments in the insectary show that, if the eggs are nearly or fully developed within the ovaries of *Nezara viridula* when the eggs of the tachinid fly (*Trichopoda pennipes*) are placed on her body, a female will

sometimes deposit eggs after being parasitized. Of course, not more than this one egg cluster is laid before the insect is destroyed. Pairs have been collected while feeding and copulating in the field during the late afternoon and both sexes died from the effects of parasitism during the following night.

When valuable garden and truck crops are heavily infested, hand collecting seems to be the best control method. The proper management and cutting of the cover or soiling crop will usually keep the insects under control in citrus groves, also in pecan groves. In case of severe infestation in citrus groves it has been demonstrated (J. R. Watson) that hand collecting with large nets can be done successfully and profitably. In using large nets the work should be done in early morning or on cool days when the temperature is below 70° F. At a higher temperature many of the adult bugs will save themselves by taking flight before they drop into the nets.

Of both wild and cultivated vegetation the insects generally show a decided preference for leguminous and cruciferous plants. During late fall, winter (individuals that do not seek protected places to hibernate) and early spring the bugs often congregate upon cruciferous plants as radish, collard, Chinese cabbage, rape, mustard, turnip, etc. Some of these plants might serve as a valuable trap crop for late fall, winter and spring. Experiments at Gainesville, Florida, during the summer show that radish and collard, both growing in the same row, will serve as a trap crop to protect tomatoes. The seed should be planted about November 1st so that the radish will be forming pods while the fruit of tomato is developing and ripening during the following spring. The insects should be gathered by hand.

Leguminous plants, as cowpeas, rattle-box, beggarweed, beans, etc., are much preferred to other plants during the summer and early fall, especially during the pod-formation period. Rattle-box, *Crotalaria urasamoensis*, probably offers one of the greatest possibilities as a trap and propagating crop during the summer. The plant itself is probably not more or perhaps as attractive to the bugs as cowpeas and beggarweed, but the blossoms are very alluring to the parasites. The principal parasite, *Trichopoda pennipes*, is a honey-loving insect and was a constant visitor to the flowers of rattle-box. From 10 to 80 per cent of the specimens of *Nezara viridula* collected on rattle-box bore eggs of *Trichopoda pennipes*. On this account it seems that rattle-box

should be grown as a propagating plant during summer and thus increase the number of parasites. The long blooming and pod-formation period adds much to the value of the plant as a trap and propagating plant.

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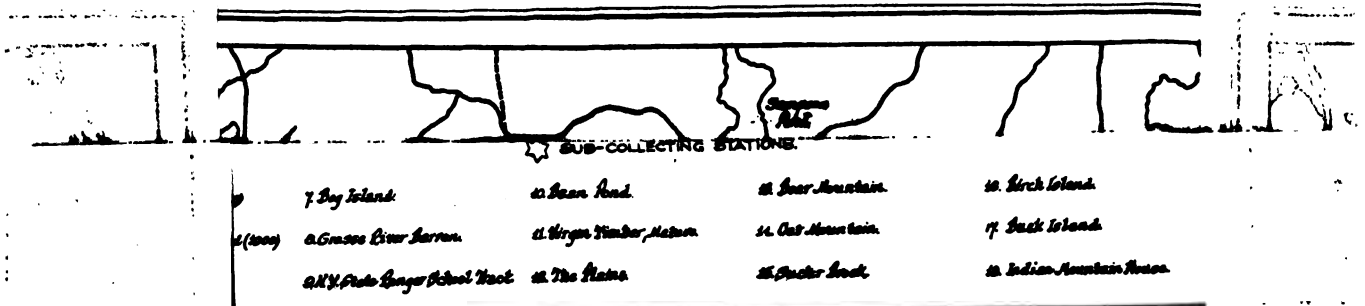
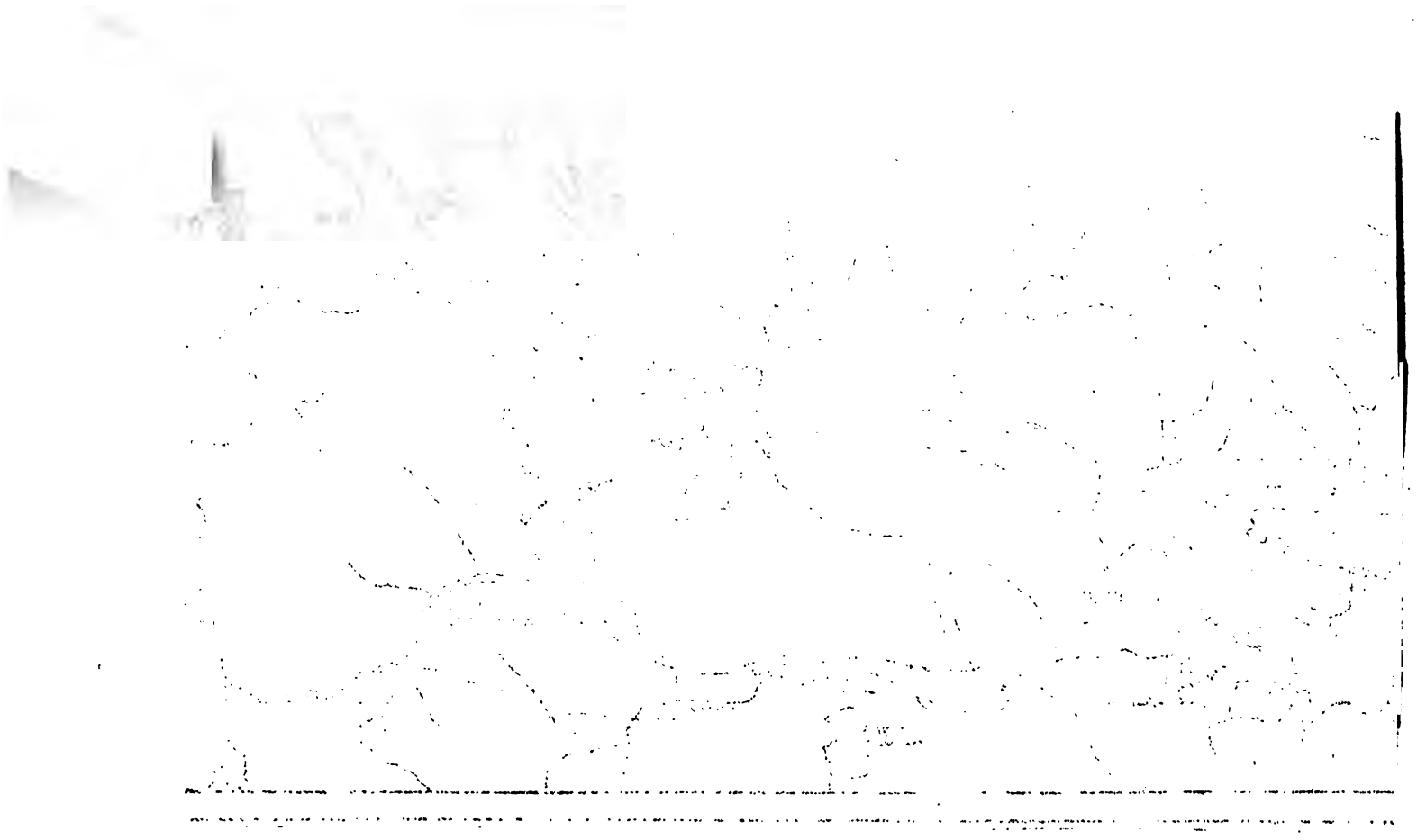


Cranberry Lake Region, New York, showing the location of Collection Station. Drawn by



HETEROPTERA IN THE VICINITY OF CRANBERRY LAKE

By Carl J. Drake

Family SCUTELLERIDAE

Homaemus aeneifrons (Say) (Fig. 22, *b*)

This insect is the most common species of the *Scutelleroidea* occurring in the vicinity of Cranberry Lake. Nymphs and adults have been taken during June, July, August and September, but most of the immature forms attain the adult state before September. The species is quite generally distributed, but it is by far more abundant in the neighborhood of low marshy meadows and swamps. Van Duzee (*l. c.*, p. 548) states that the insect is very generally distributed and common in the Adirondacks where there were low, marshy spots with carices intermixed with swampy grasses. He took an adult upon a species of *Scripus* on the summit of Cobble Hill.

This *scutellerid* is quite variable in both size and color. The color varies from pale yellow or dull to quite dark or blackish forms. The dull or glossy or pale color-forms are often more or less variegated with fuscous or black, thus giving the insect a marbled appearance. The size ranges from 6.5 mm. to 9.5 mm. in length.

Eurygaster alternatus (Say).

Four specimens, taken at Wanakena and Barber Point near a grassy bog in an old burn. Osborn collected a specimen while sweeping in the Grasse River Bog.

Family CYDNIDAE

Thyreocoris ater (Amyot and Serville).

Two specimens: Barber Point and Wanakena, July, 1920.

Thyreocoris pulicarius (Germar).

One specimen, taken on grass, July 30, at Wanakena in an old burn.

Sehirus cinctus (Palisot de Beauvois) (Fig. 22, *a*).

Barber Point, Wanakena and the Plains. This insect is not uncommon and feeds upon weeds growing in small open areas. Specimens have been collected during June, July, August and September.

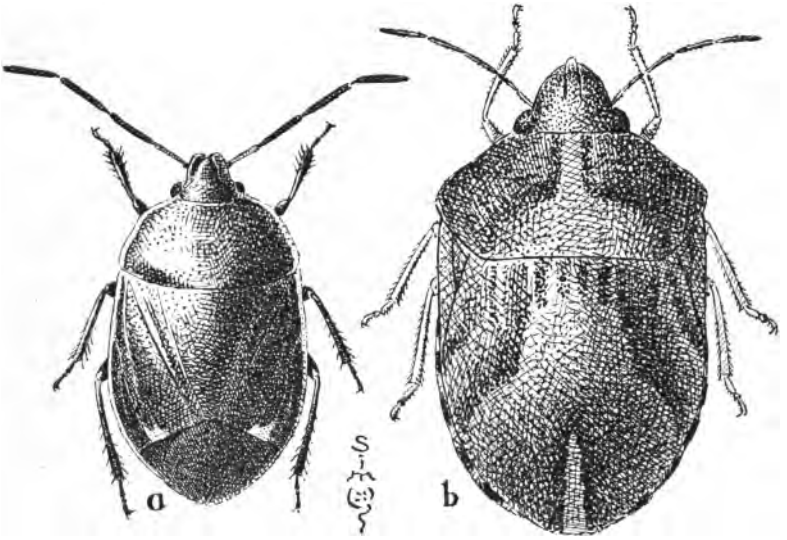


Fig. 22.— *a*, *Homaemus aeneiforns* (Say); *b*, *Sehirus cinctus* P. B.

Family PENTATOMIDAE

Sciocoris microphthalmus Flor.

Eight specimens, taken during July and August while sweeping grasses and rank weeds at Barber Point and Wanakena. I have very carefully collated the specimens with a male and female in the late Puton's collection (from Paris Museum) and find the American specimens identical with European examples determined by the late Puton. This seems to be the only record for New York State. The insect has been recorded for Ontario, New Hampshire, Maine, Michigan and Minnesota.

Peribalus limbolarius Stal.

One example, collected at the Plains, July, 1920.

Chlorochora uhleri Stal.

Crataegus Hill at Barber Point and Plains during August, 1920. This is not a common species in the vicinity of Cranberry Lake.

Mormidea lugens (Fabricius).

Common: Barber Point, Wanakena and the Plains during July, August, and September, 1917, 1919, and 1920. Numerous specimens were observed breeding and feeding on mullein, *Verbascum Thapsus* Linn. at the Forestry Camp. Many examples were also collected while sweeping various herbaceous plants.

Euschistus euschistoides (Vollenhoven).

Barber Point, Wanakena, Plains and Conifer. This insect seems to be a general feeder upon many herbaceous plants and sometimes on birch, beech and poplar trees. It hibernates in the adult state. The eggs are frequently parasitized by a small hymenopterous parasite.

Euschistus tristigmus (Say).

This is the most common pentatomid in the vicinity of Cranberry Lake and is found during the entire summer. It is a general feeder upon herbaceous plants and also frequently breeds on trees (white and yellow birch, ironwood, poplar, beech and maple). Adults and nymphs have also been collected on the blossoms of wild spiraea (*Spiraea lalifolia*, Borkh.). Several adults were taken bearing tachinid eggs, but the parasite failed to develop in the laboratory. Hymenopterous parasites have reared from its eggs.

Euschistus variolarius (Polisot de Beauvois).

Wanakena and Barber Point, July and August, 1919 and 1920. Not common.

Coenus delius (Say).

One adult and several large nymphs were collected while sweeping grasses and weeds in a semi-marshy place near a small stream in the Plains during the last week of July, 1920.

Neottiglossa undata (Say).

Common: Barber Point, Wanakena, Conifer and the Plains during June, July and August, 1920. It is found on herbaceous plants.

Cosmopepla bimaculata (Thomas).

Common on weeds and rank vegetation. Adults and nymphs were noted at various times during the summer feeding on mullein.

Thyanta custator (Fabricius).

An adult and several nymphs were collected at the Plains, Crataegus Hill and Barber Point, 1920.

Banasa dimidiata (Say).

Very common: Barber Point, Wanakena, Plains, Crataegus Hill, and Conifer. Adults and nymphs have been found on yellow birch, beech and also on various herbaceous plants. The eggs are frequently parasitized by a small hymenopterous parasite.

Meadorus lateralis (Say) (Fig. 23, *b*).

This is largely a tree-inhabiting species. Specimens have been observed depositing eggs on yellow birch and beech at Barber Point during June, July, and August. The winter is spent in the adult state. My records indicate two generations a year during the summers of 1919 and 1920.

Nymphs and adults were taken in the tops of large yellow birch trees (felled for catkins while studying the insects affecting reproduction of yellow birch) in the vicinity of Barber Point during July, August and September, 1920, by Mr. Eric Johnson and the writer. In some very tall trees many nymphs, representing three or four instars, and adults were feeding on the leaves and catkins. Adults were also reared from eggs and nymphs (taken from the tree tops) on catkins placed in glass breeding cages in the insectary. *M. lateralis,* although sometimes taken while sweeping herbaceous plants, is primarily a tree-inhabiting species. It also breeds on white birch and beech trees.

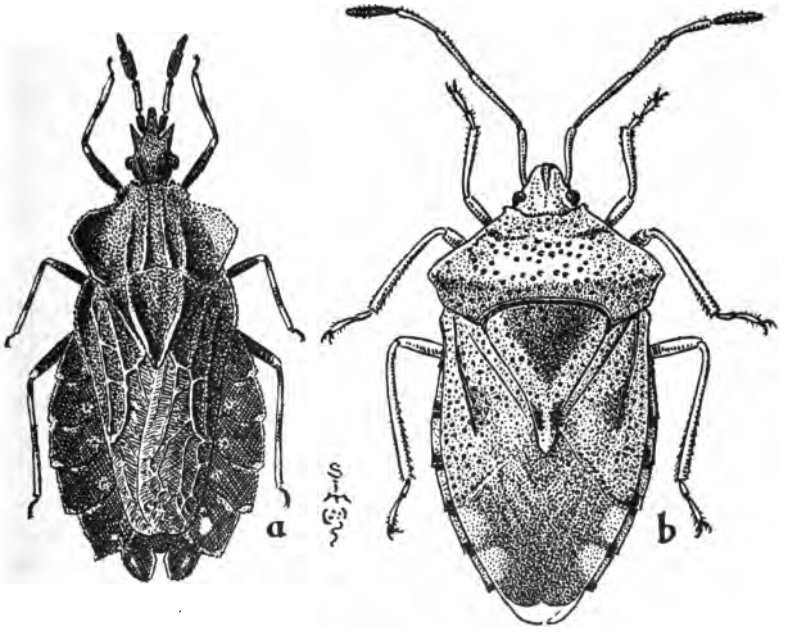


Fig. 23.— *a*, *Aradus quadrilineatus* Say; *b*, *Meadorus lateralis* (Say).

Elasmotethus cruciatus (Say).

Barber Point and Wanakena, August, 1917, 1919, and 1920.

Elasmostethus atricornis (Van Duzee).

Barber Point, August, 1920.

Mineus strigipes (Herrich-Schaeffer).

Four examples, collected at Barber Point, July 19 and 26, 1920, and one specimen at Wanakena, August 1, 1917.

Perillus circumcinctus Stal.

Two examples, Wanakena, July 30, 1917, and two specimens at Barber Point, August, 1920.

Perillus exaptus Say, var. *d* Van Duzee.

A single specimen of this variety was taken while sweeping rank vegetation near a small stream in a semi-aquatic place in the Plains, August, 1920. Van Duzee lists var. *d.* from Colorado and Washington. The typical form is a widely distributed species, extending from Vancouver to Quebec and southward to Colorado, New Mexico and New Jersey (*fide* Van Duzee).

Podisus serieventris Uhler.

Abundant: Barber Point, Plains, Wanakena, Floating Island, Buck Island and Conifer, June, July, August and September, 1917, 1919 and 1920.

Podisus modestus (Dallas).

Common: Barber Point, Wanakena and Plains, June, July, August and September, 1917, 1919 and 1920.

Podisus placidus Uhler.

Several specimens: Barber Point, Plains and Wanakena, June, July and August, 1917, 1919 and 1920.

Podisus maculiventris (Say).

Barber Point and Wanakena, 1917, 1919 and 1920. Osborn found a specimen on yellow birch feeding upon a frog-hopper, *Clastoptera obtusa* (Say) and the writer took a specimen on a willow tree with its beak impaled in a lampyrid beetle.

Family COREIDAE

Protentor belfragei Haglund (Fig. 24, *a*).

This specimen seems to be more or less locally distributed in small, grassy areas, but frequently abundant in these habitats. Wanakena (on an open grassy hill side at "French Camps"), Barber Point and Plains, July, August and September, 1917, 1919 and 1920. This is the most common coreid taken in the vicinity of Cranberry Lake.

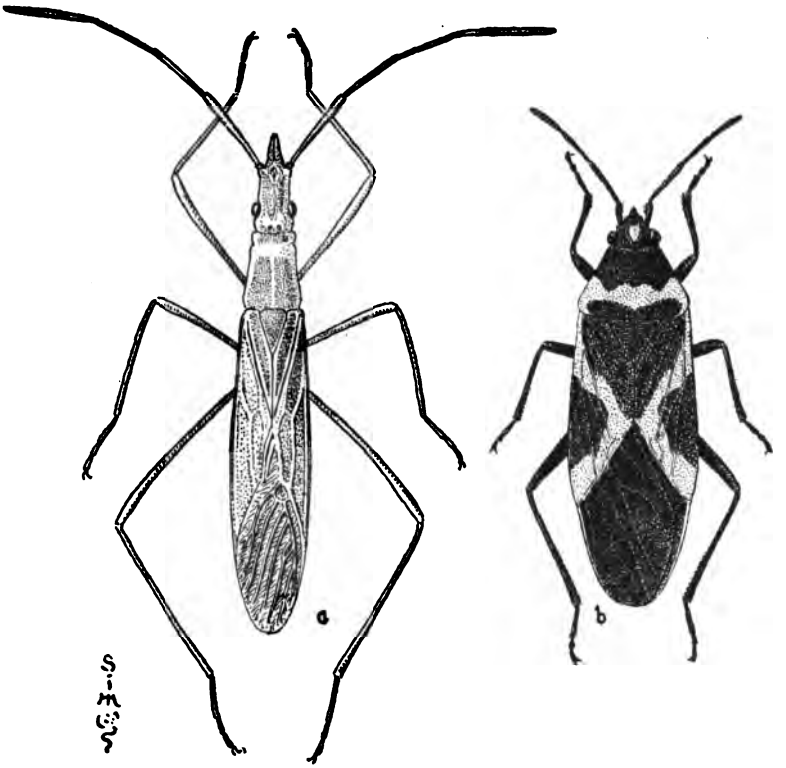


Fig. 24.— *a*, *Protentor belfragei* Haglund; *b*, *Lygaeus kalmii* var. *angustomarginatus* Parsh.

Alydus eurinus (Say).

Two specimens: Barber Point and Wanakena, July, 1919 and 1920.

Alydus conspersus Montadon.

Several specimens: Barber Point, Wanakena and Plains, 1917, 1919 and 1920.

Corizus crassicornis (Linnaeus).

Numerous specimens: Barber Point, Wanakena and the Plains during July and August, 1917, 1919, and 1920.

Corizus lateralis (Say).

Two specimens, collected at Barber Point, July 1, 1920.

Family ARADIDAE

Aradus quadrilineatus Say (Fig. 23, *a*).

Several specimens: Two adults and a few nymphs, representing three instars, were found under the bark of a decaying beech log at Barber Point during July by Osborn; one specimen between

the crevices of the bark of a recently felled yellow birch tree, Barber Point, August, 1919; Mr. Fivaz took two specimens on the window of the insectary, June 27, 1920.

Aradus robustus Uhler.

One specimen, taken on a yellow birch log, July 19, 1919.

Aradus ornatus Say.

One specimen, collected on the window of the insectary, July 20, 1920.

Aradus similis Say.

Common, Barber Point and Wanakena. This insect breeds in the crevices of the bark of dead spruce and hemlock. Eggs, nymphs and adults were taken during the summers of 1917, 1919 and 1920.

Aradus similis centriguttatus Bergroth.

Taken with the typical form on spruce and hemlock, Barber Point, 1920.

Aradus tuberculifer Kirby.

Barber Point, July 24, 1917; taken about noon as the insect happened to alight on the side of a tent.

Aradus lugubris Fallen.

Several specimens, taken on the windows of the insectary during July, 1919 and 1920. One specimen collected on a yellow birch log at Barber Point, June 25, 1919.

Aradus lugubris var. **nigricornis** Reuter.

Taken with the typical form on the windows of the insectary at Barber Point.

Aradus abbas Bergroth.

Barber Point, June 17 and July 26, 1919; collected on a tent at camp.

Aradus proboscideus Walker.

Three adults and many nymphs, taken in the crevices and beneath the bark of an old dead spruce tree at Barber Point (in Beaver Meadow), July 9, 1917.

Aradua niger Stal.

Several specimens collected by Mr. Hide and the writer on a pine log at Barber Point, July 10, 1917.

Aneurus inconstans Uhler.

Barber Point, June and July, 1919. One specimen was found on an old yellow birch log, near the Beaver Meadows, June 26, 1919.

Aneurus simplex Uhler.

Many specimens, taken at Barber Point beneath the loose bark of a small dead beech tree, July 20, 1917. Fivaz found a specimen on a spruce log, at Barber Point, July 22, 1920. Numerous specimens were taken on the windows of the insectary at various times (of the days) during the summer of 1920.

Family NEIDIDAE

Neides muticus (Say).

Several examples, taken at Wanakena, Barber Point and Plains during July and August, 1917, 1919 and 1920.

Family LYGAEIDAE

Lygaeus kalmii Stal subsp. **angustomarginatus** Parshley (Fig. 24, *b*).

Common on the ground at Barber Point during July and August, 1919 and 1920. A couple of specimens were also collected at Wanakena, August, 1920 (*fide* Parshley).

Ortholomus longiceps (Stal).

Very common in open areas on rank grasses and weeds at the Plains and on Big Floating island during July and August, 1920. Several specimens: Wanakena, July and August, 1917.

Nysius thymi (Wolff).

Common: Wanakena, Barber Point and the Plains, June, July and August, 1919 and 1920.

Nysius ericae (Schilling).

Common: Barber Point and Wanakena, July and August, 1917, 1919 and 1920.

Ischnorrhynchus geminatus (Say) (Plate 11, Fig. *g*).

Very abundant, especially in swampy and marshy areas; Barber Point, Wanakena, Conifer Plains and "Big Floating island." Numerous specimens were also found during July and August, 1919, on the tops of large yellow birch trees. Specimens were bred from both yellow and white birch catkins in breeding stages during July, August and September, 1919, by Mr. Eric Johnson and the writer.

Cymus luridus Stal.

Barber Point and Wanakena during July, 1917.

Cymus angustatus Stal.

Very abundant during June, July and August, 1917, 1919 and 1920, at Barber Point, Wanakena and the Plains. The insect was collected by sweeping grasses and herbaceous plants.

Cymus discors Horvath.

Common during the entire summer: Barber Point, Wanakena, Plains and Conifer. Most of the specimens were taken in open areas on rank vegetation and in swampy places. A few specimens were collected on *Salix* spp.

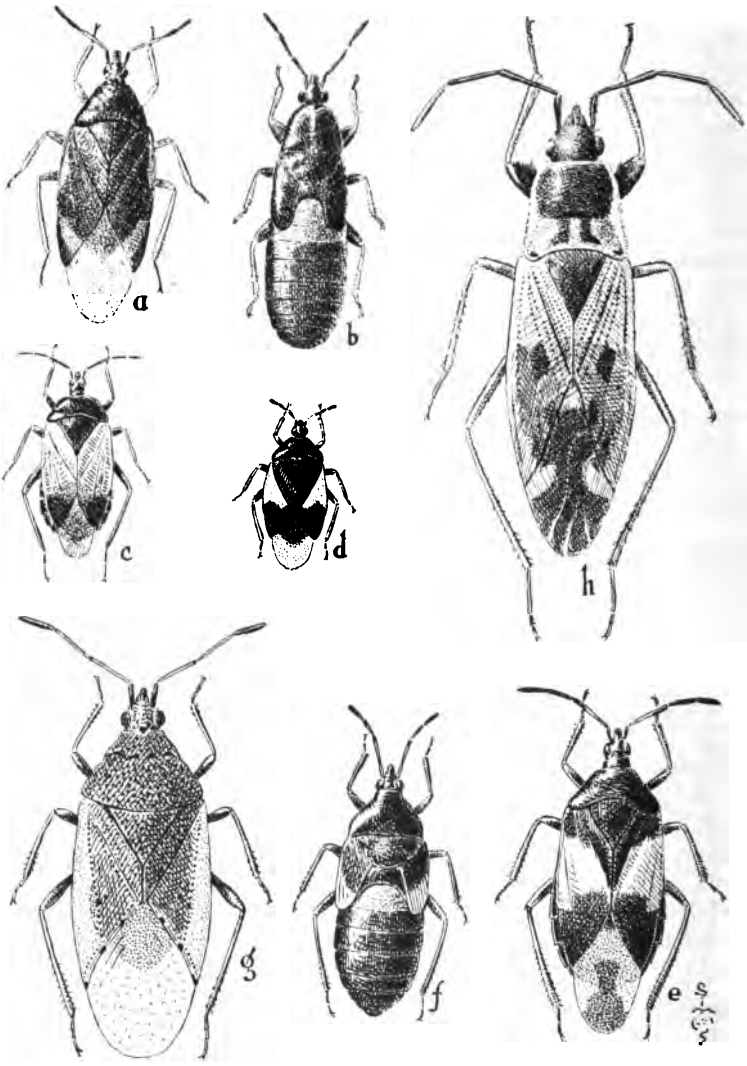


Plate II.

a, Tetraphleps osborni, n. sp.; *b, Anthocoris* ? sp. ? *c, Asthenidea temnostethoides* Reut.; *d, Triphleps insidiusus* Say; *e, Anthocoris borealis* Dall.; *f, A. borealis,* last instar; *g, Ischnoshynchus geminatus* Say; *h, Eremocoris ferus* (Say).

Geocoris bullatus (Say).

Barber Point, July, 1917.

Geocoris uliginosus (Say).

Several specimens, collected in open areas at the Plains, July, 1920.

Geocoris uliginosus lateralis Fieber.

Wanakena, August 12, 1920, in the "old burn" back of the Ranger School.

Phylegas abbreviatus (Uhler).

Four specimens, taken at the Plains, August 2, 1920.

Oedancala dorsalis (Say).

Wanakena, July, 1917, sweeping weeds and grasses.

Crophius disconotus (Say).

Numerous specimens, sweeping rank vegetation in open areas at the Plains, August, 1920.

Myodochus serripes Oliver.

Wanakena, July, 1917.

Ligyrocoris diffusus (Uhler).

Very common in open areas: Barber Point, Plains, Wanakena and Conifer during the summers of 1917, 1919 and 1920.

Ligyrocoris contractus (Say).

This insect, like *L. diffusus* Uhl., could always be found on herbaceous plants in open areas at Barber Point, Plains, Conifer and Wanakena.

Perigenes constrictus (Say).

One specimen, collected at the Plains, August 29, 1920.

Antillocoris pallidus (Uhler).

One specimen, Wanakena, Aug. 1–7, 1917.

Stygnocoris rusticus Fallén.

Two specimens, Barber Point, August 1, 1917.

Eremocoris ferus (Say) (Plate 11, Fig. *h*).

Four specimens on yellow birch, Barber Point, July 21, 1919. One specimen, July, 1917, beneath the loose bark of a balsam stump at Wanakena. The latter specimen had just moulted and was not fully colored at the time of capture. Two specimens were taken at Conifer (September, 1917) beneath the loose bark of an old yellow birch stump by Mr. Johnson and the writer.

Family PIESMIDAE

Piesma cinerea Say.

One example, taken "in flight," Barber Point, July, 1919, at noon in the mess hall, by Mr. Marquardt.

Family TINGITIDAE

Corythucha pergandei Heidemann.

Common on alder, taken at Barber Point, Plains and Wanakena during the entire summer. This species spends the winter in the adult state; there are two generations a year in the Adirondacks.

Corythucha bellula Gibson.

Common on alder, but not taken in the same association with *heidemanni*. Barber Point and Wanakena, June, July and August, 1917, 1919 and 1920.

Corythucha marmorata Uhler.

Not common, swept from weeds at Barber Point, July, 1920.

Corythucha mollicula Osborn and Drake (Fig. 25, *c* and *d*).

Common on various species of willow, but not as abundant as *elegans* Drake. Barber Point, Plains, Conifer and Wanakena during the entire summer. This insect also hibernates during the

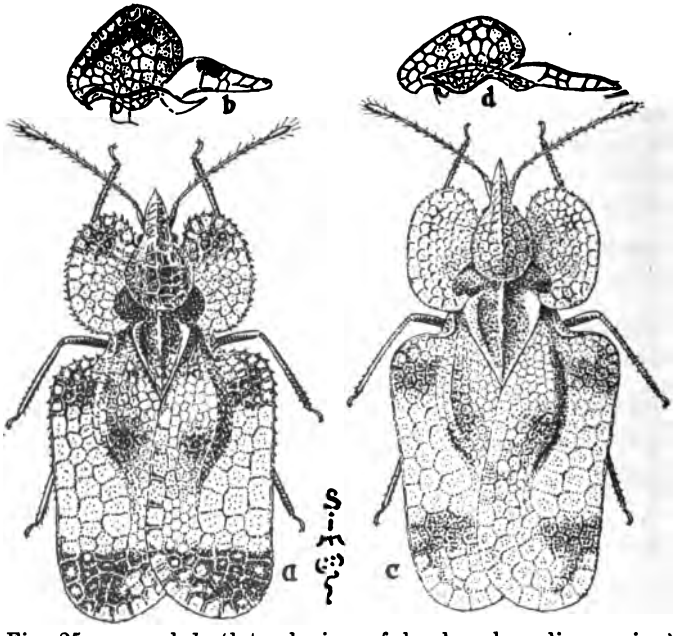


Fig. 25.— *a* and *b* (lateral view of hood and medina carina), *Corythucha elegans* Drake; *c* and *d* (lateral view of hood and median carina), *Corythucha mollicula* O. & D.

Fig. 26.—Eggs of *Corythucha elegans*. Photo by Drake.

winter in the mature state. *Salicis* Osborn and Drake and *canadensis* Parshley are synonyms of this species. It is very variable in size and somewhat in color.

Corythucha elegans Drake (Fig. 25, *a* and *b*; Fig. 26, eggs).

Taken on *Salix* spp. at Barber Point, Wanakena, Plains and Conifer. This species and the following, *C. pallipes* Parshley, are by far the most abundant species of *Heteroptera* living in the vicinity of Cranberry Lake. It is not uncommon to find the leaves of badly infested trees greatly discolored and almost entirely destroyed by their feeding punctures. *Elegans* also hibernates in the adult state. The nymphal stages are represented by five instars and there are two generations a year at Barber Point. The eggs are laid in irregular rows on the ventral side of the leaves along either or both sides of the principal veins. The nymphs feed in clusters during the early stages. Occasionally the species breeds on poplars, *Populus tremuloides* Michx. and *Populus grandidentata* Michx. A few seedings of the large-tooth poplar were very badly infested during the past summer, 1920, at Barber Point, but willow seems to be the preferred food-plant. *Anthocoris borealis* and the larvae of a lace-wing fly. *Chrysopa* sp. were observed preying upon this insect in the field.

Corythucha pallipes Parshley (Plate IV, Fig. 44).

This insect is usually found in immense number on yellow birch in the vicinity of Cranberry Lake. It also breeds on white birch, beech, ironwood and occasionally on mountain ash and hard

and soft maple. *C. betulae* Drake and *C. cyrta* Parshley are synonyms of this species. The life history of *pallipes* is discussed in another paper in this bulletin.

Galeatus peckhami Ashmead (Plate V).*

About 200 specimens, taken upon aster, *Aster macrophyllus,* and boneset, *Eupatorium* sp. at Barber Point (summit of Crataegus Hill) during the last week of July and August, 1920, by Dr. Osborn and the writer. The life history of this insect is also discussed in another paper herein.

Melanorhopala clavata Stal.

Several specimens, taken near a small stream on tall weeds at the Plains during the latter part of August, 1920.

Family REDUVIIDAE

Reduvius personatus (Linnaeus).

One specimen, collected at Indian Mountain House, near Barber Point, by Mr. Leland Slater, 1920.

Sinea diadema (Fabricius).

Common: June, July, August and September at Barber Point, Wanakena, Conifer, Childwold and the Plains, 1917, 1919 and 1920.

Family CIMICIDAE

Cimex lectularius (Linnaeus).

This pest is sometimes very common in old houses, hotels and lumber camps. Its ability to undergo long fasts frequently enables the insect to maintain itself in camps and dwellings not inhabited during the entire year. It is sometimes a serious pest in lumber camps in the vicinity of Cranberry Lake, the crevices between the logs offering a very favorable hiding and breeding place. While riding on the train between Conifer and Cranberry Village the writer found a specimen crawling about on a seat in the day coach.

Family ANTHOCORIDAE

Asthenidea temnostethoides Reuter (Plate II; *c, adult*).

Two specimens, collected at Barber Point, Sept. 16, 1917, and August 5, 1920. Van Duzee gives its habitat as Illinois (*fide* Barber).

Anthocoris borealis Dallas (Plate II; *e, adult,* and *f,* nymph in last instar).

This preditor is a common in eastern United States and Canada. My records indicate that it is primarily a tree-inhabiting species and preys largely upon leaf-feeding insects. It shows a decided preference for deciduous leaf-destroying insects and seems to be

* See footnote, p. 105.

by far most common on willow. Many adults and nymphs, representing three or four instars, were collected on *Salix* spp. during the summers of 1917, 1919 and 1920. Adults have been observed in the field with their beaks impaled in *Corythucha elegans* Drake, *C. mollicula* O. & D. and *C. pallipes* Parshley. The writer has also found the insect in the egg-galleries of several bark beetles (Ohio Journal Science, Vol. XXI, pp. 201–206, 1921), but it does not seem to breed or normally live there. Field observations during the summers of 1919 and 1920 show only one generation a year, the first adults beginning to emerge about the middle of July. Only the larger nymphs and adults were collected during the latter part of the summers.

Anthocoris —— sp. (Plate II; *b*).

This peculiar and very interesting insect was only taken in the nymphal stages. It lives largely in the burrows of bark and ambrosia beetles or in the crevices and beneath the scales of the bark of coniferous trees, particularly spruce. It is rarely found in the galleries of *Ipidae* in hardwoods. Specimens (Drake, Ohio Journal of Science, Vol. XXI, pp. 201–206, 1921) have been found in the burrows of *Polygraphus rufipennis* Kirby, *Dryocoetes piceae* Hopkins, *Dryocoetes americana* Hopkins, *Orthotomicus caelatus* Eichlr., *Trypodendron bivittatum* Kirby, *Ips pini* Say, *Pityogenes hopkinsi* Swaine, *Trypodendron betulae* Swaine, *Anisandrus obesus* Le Conte and *Xyloterinus politus* Say. Four distinct nymphal stages were found in the burrows of *Polygraphus rufipennis, Dryocoetes americana* and *Orthotomicus caelatus* in spruce logs that had been felled during the previous winter (1919). Only very young nymphs, probably the second and third instar were found during the latter part of May and forepart of June; later in the summer only the large nymphs were collected. Nymphs, probably in the last two instars, were placed in breeding cages at Barber Point and then carried to Syracuse about the first of September. These specimens were fed small insects, but they all died before they reached the mature state. Records seem to indicate that the adult state is probably found during the late fall. Numerous specimens taken in the field about the first of September, 1920, were mostly in the last instar. The insect is undoubtedly an important enemy of both bark and ambrosia beetles, also other small and very young larvae of wood-destroying insects. In the breeding cages the nymphs readily feed upon small larvae and insects, also upon dead larvae and dead insects.

Tetraphleps osborni n. sp. (Plate II; *d*).

Head, thorax and abdomen dark piceous and shining. Abdomen beneath dark piceous sometimes slightly tinged with reddish brown, the pubescence sparse and grayish. Hemelytra brown or dark brown, with greater part of embolium and cuneus lighter; membrane smoky, usually with pale streaks following the nervures. Pubescence fine, slightly curled, pale. Antennae dark brown, the

second segment lighter; third and fourth segments subequal in length; second segment equal to the first and third conjoined, the first slightly more than half the length of the third. Legs with basal portion of femora and tarsi dark brown to nearly black, the rest lighter.

Pronotum with explanate margins narrow, distinctly and roundly emarginate on the posterior border, distinctly and transversely rugulose on the collum and basal portion, a smooth somewhat crescent-shaped area just back of the collum, the pubescence grayish, fine and mostly prostrate. Rostrum reaching between the middle coxae. Head quite sparsely pubescent, its length distinctly longer than its width (diameter through eyes). Male genital claspers curved. Length 3.2—3.45 mm.; width 1.15—1.27 mm.

Numerous specimens, taken on white pine trees, at Barber Point, Wanakena and the Plains during July, August and September, 1917, 1919 and 1920. The male is a little more slender than the female. This insect seems to feed largely upon the leaf-feeding insects of conifers, particularly white pine, *Pinus strobus*. Nymphs and adults could be found at all times during the summer upon the pine trees but only larger nymphs and adults during the latter part of the season. There is only one generation a year. The insect has been bred from the burrows of *Cryptorhynchus lapathi* by the writer (l. c., p. 203). I am indebted to Dr. H. M. Parshley for kindly comparing this insect with his types of *T. concolor* and *T. americana*.

Triphleps insidiosus (Say) (Plate II; *a*).

This is a common species in the family. It is a grass- and an herb-inhabiting insect, especially common in open grassy areas. It is also predaceous and adults have been reported as feeding upon eggs as well as nymphs and adults of other insects. Barber Point, Wanakena, Conifer, and Plains, June, July, August and September, 1917, 1919 and 1920.

Family MESOVELIIDAE

Mesovelia mulsanti White.

Common, collected at Bean Pond, Cranberry Lake, and other small ponds and lakes in the vicinity of camp. It prefers quiet waters containing an abundance of aquatic plants. Both apterous and macropterous forms were taken, the wingless individuals being the most numerous. Its life history and habits have been described by Hungerford (l. c., pp. 101–105).

Family NABIDAE

Pagasa fusca (Stein).

Barber Point, July and August, 1919.

Nabis subcoleoptratus Kirby.

June, July and August, 1917, 1919, and 1920, collected at Wanakena, Barber Point, Conifer and Plains. This preditor occurs

mostly in the wingless forms and feeds largely upon the insects living on herbaceous plants. One alate individual was taken by the writer on some semiaquatic plants in the Plains.

Nabis limbatus Dahlbom (Fig. 27, *a*).

This insect is especially abundant upon rank vegetation growing in swamps, bogs and semiaquatic places. June, July, August and September at the Plains, Barber Point, Wanakena and Conifer.

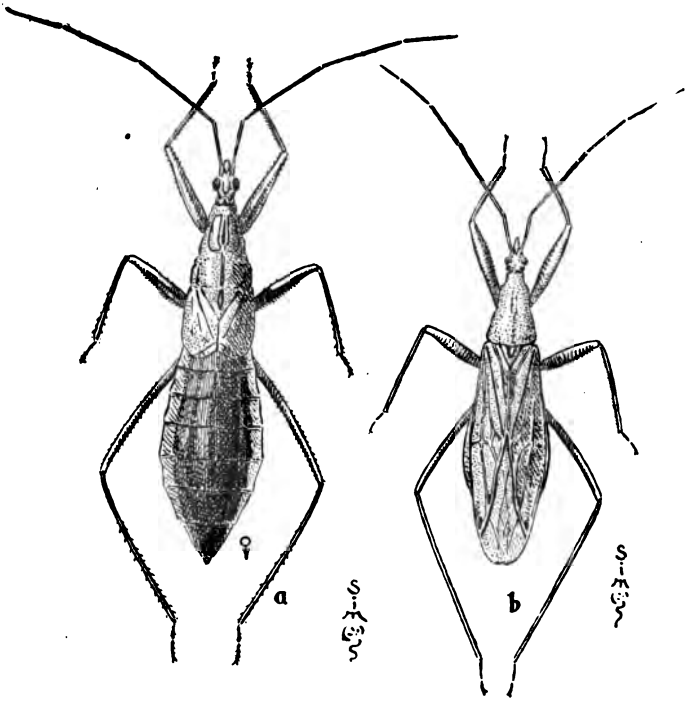


Fig. 27.— *a, Nabis limbatus* Dahl; *b, Nabis rufusculus* Reuter.

Nabis ferus (Linnaeus).

Common, but never taken in large numbers like the preceding or two following species. This insect prefers open grassy areas and feeds largely upon grass-destroying insects. Osborn states that it is an important enemy of the Meadow Plant-bug, *Miris dolobrata,* in Maine. Barber Point, Wanakena and Plains, 1919 and 1920.

Nabis roseipennis Reuter.

Very common (long- and short-winged forms) at Barber Point, Plains, Conifer and Wanakena during June, July, August and September, 1917, 1919 and 1920. *Roseipennis* inhabits the deep woods, lumbered tracts, and " burns " but seems to prefer more

or less open areas along trails and tote-roads. It feeds almost entirely upon grass- and herb-inhabiting insects.

Nabis rufusculus Reuter (Fig. 27, *b*).

Barber Point, Conifer, Plains and Wanakena, summers of 1917, 1919 and 1920. This species, like the preceding, is very common (both long- and short-winged forms) in the vicinity of Cranberry Lake and lives in a great variety of habitats, but seems to be more at home in the somewhat open areas along the trails and tote-roads. Numerous specimens were also collected on huckleberry bushes in bogs at Barber Point and Wanakena. In the latter habitat it was also taken with *N. limbatus*. Eggs of *rufusculus* were observed in the stems of asters (*Aster macrophyllus*) on crest of Crataegus Hill, Barber Point, 1920, by the writer. These asters were badly infested by aphids, a tingid and a small mirid. *Rufusculus* and the other species of nabids listed above are preëminently wandering, grass- or herb- or very low shrub-inhabiting species and preys upon the insects found on these plants. They are rarely taken, and perhaps never breed, upon tall shrubs or trees.

Family MIRIDAE

Collaria meilleurii Provancher.

Very common, especially in small open areas upon rank vegetation. Barber Point, Wanakena, Plains and Conifer during the latter part of June, July, August and September.

Collaria oculata (Reuter).

Barber Point, Plains and Wanakena, taken in company with *C. meilleurii,* but not in such large numbers.

Miris dolobrata (Linnaeus).

Very abundant in open dry grassy areas, especially along the trails in the old burned over areas. Barber Point, Wanakena and Plains during June, July and August. The winter is spent in the egg stage and the young nymphs are often very numerous on grasses, especially timothy, in the forepart of June. The life history and habits of this insect, commonly called the "meadow plant-bug," has been published by Osborn in Journ. Agr. Research, Vol. XV, No. 3, pp. 172–201.

Stenodema trispinosum Reuter.

Barber Point, Wanakena, Plains and Conifer, June, July and August. At Barber Point this insect was quite common on tall grasses and weeds along the trails and in the Beaver meadow.

Stenodema vicinum (Provancher).

Barber Point, Wanakena, Plains and Conifer, collected in company with *S. trispinosum* and *T. ruficornis.*

Trigonotylus ruficornis (Geoffroy).

Several specimens, taken at Barber Point, Plains and Wanakena,

Trigonotylus pulcher Reuter.
Barber Point, July 20, 1917.

Teratocoris paludum Sahlberg.
This palaearctic species was collected by Osborn in the Grasse River Bog, near Conifer, July 22, 1920.

Platytylellus insitivus (Say).
Barber Point, July, 1920.

Platytylellus rubrovittatus (Stal).
Several specimens, taken during July and August in the Beaver Meadow and bog at Barber Point.

Platytylellus sp.
Barber Point, July 5 and 13, 1920.

Platytylellus nigricollis Reuter.
Barber Point and Conifer, July and August, 1920.

Neurocolpus nubilus Say.
Barber Point, July, 1920.

Mimoceps gracilis Uhler.
Sweeping weeds at Barber Point and the Plains in July.

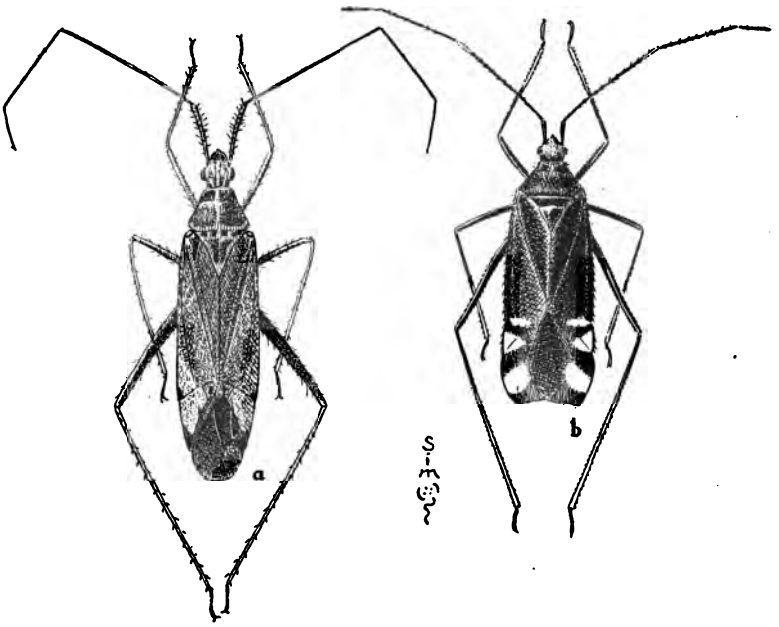


Fig. 28.— *a*, *Phytocoris lasiomerus* Reuter; *b*, *Macrotylus sexguttatus* Prov.

Phytocoris lasiomerus Reuter (Fig. 28, *a*).

Barber Point, Plains and Wanakena, July and August. Specimens were taken on *Salix* and also by sweeping weeds at Barber Point.

Phytocoris pallidicornis Reuter.

Barber Point, Plains and Wanakena.

Phytocoris cortitectus Knight.

A male, taken at Barber Point, July 20, 1921.

Phytocoris eximius Reuter.

Wanakena, August 12, 1920.

Phytocoris salicis Knight.

On *Salix*, Barber Point, August 12, 1920, and Wanakena, July 24; on yellow birch, in the burned over tract at Barber Point, July 24, 1920.

Phytocoris erectus Van Duzee.

Wanakena, August 12, 1920.

Phytocoris fulvus Knight.

Common on white pine during July and August at Barber Point and Wanakena.

Adelphocoris rapidus Say.

Very common on numerous herbaceous plants, especially in open areas. The insect is found throughout the greater part of the United States and Southern Canada, often becoming a rather serious pest upon a number of cultivated plants. Barber Point, Wanakena, Conifer and Plains during the entire summer. A female, taken at the Plains, August 25, has a black head like some of the western varieties.

Stenotus binotatus (Fabricius).

Several specimens, taken at Barber Point, Wanakena, Conifer and Plains during July and August.

Garganus fusiformis (Say).

Barber Point, July and August, 1920-1921.

Poeciloscytus unifasciatus (Fabricius).

Barber Point and Wanakena, July, 1917 and 1920.

Poeciloscytus venaticus Uhler.

Very common along the trails and tote-roads in the burns at Barber Point and Wanakena during the entire summer.

Horcias dislocatus (Say).

Barber Point, July, 1920.

Horcias dislocatus affinis (Reuter).

Sweeping grasses and weeds at Wanakena, August 1–7, 1917, and Barber Point, August 12, 1920.

Horcias dislocatus limbatellus (Walker).

Taken along the old tote-road in the burned over track, Wanakena, August 1–7, 1917.

Peocilocapsus lineatus (Fabricius).

Common in open areas during the summers of 1917, 1919 and 1920. Barber Point, Wanakena and Plains. Specimens have been taken on the blossoms of wild *spiraea, Spiraea latifolia* Borkh. in the old burn, beaver meadow and cut-over areas at Barber Point.

Capsus ater (Linnaeus).

Very abundant on grasses and weeds in open places along the tote-roads and trails. Barber Point, Wanakena and Plains during the summers of 1917, 1919 and 1920.

Coccobaphes sanguinarius Uhler.

Several specimens, collected at Barber Point, Wanakena and Plains. Most of the specimens at Barber Point were found on striped maple and mountain ash.

Lygidea rubecula (Uhler).

Several examples, Barber Point, July and August, 1919 and 1920.

Lygidea rubecula obscura Reuter.

Many nymphs and adults on *Salix* spp. Barber Point, Wanakena, and Plains, July and August, 1917, 1919 and 1920.

Platylygus luridus (Reuter).

Barber Point and Wanakena during the later part of June, July and August. The insect was found breeding on white pine at Barber Point.

Lygus pratensis oblineatus Say.

Barber Point, Plains and Wanakena, 1917, 1918, 1920. This insect is very common and feeds on a great variety of plants.

Lygus vanduzeei Knight.

Very common, taken at Barber Point, Plains and Wanakena, 1917, 1919 and 1920. This species hibernates in the adult state and breeds largely on golden rod. Adults have been found feeding on the blossoms of *Spiraea* at Barber Point.

Lygus vanduzeei rubroclarus Knight.

Common at Barber Point, Plains and Wanakena duing the summers of 1917, 1919 and 1920. This species is also common on the blossoms of spiraea and meadow rue. Adults have been taken on *Salix* spp. and golden rod.

Lygus plagiatus Uhler.

Sweeping weeds along the old tote-roads and trails at Barber Point and Wanakena during June, July and August.

Lygus pabulinus (Linnaeus).

Wanakena, Plains and Barber Point during June, July and August. The insect lives in cool moist places and Knight (l. c., p. 597) records the species breeding on touch-me-not, *Impatiens biflora*. The winter is spent in the adult state in Finland. Knight states that Crosby found a female hibernating beneath the bark of a tree in November in Cayuga county, and he also believes that it is quite probable that the species also passes the winter in the egg stage in the dried stems of the host plant.

Lygus approximatus Stal.

Wanakena and Barber Point, July and August, 1917. Knight took many adults on *Salidago macrophylla* near the summit of Whiteface Mountain, New York.

Lygus fagi Knight.

Breeds on yellow birch and beech. Barber Point, July and August, 1920. It prefers cool, shady locations and the eggs hatch in early spring. Adults were also found on maple at Barber Point.

Lygus atritylus Knight.

A very common insect on *Salix* spp. in moist, shady situations. Nymphs were very abundant on willow during May and early June and the adults and larger nymphs during the latter part of June, July and forepart of August. Barber Point and Wanakena, 1919 and 1920.

Lygus alni Knight.

Barber Point and Wanakena. Breeds on alder (*Alnus incana*), yellow birch (*Betula lutea*). Adults have also been swept from *Salix* spp. Winter is spent in the egg stage and adults are found during the latter part of June, July and August.

Lygus parshleyi Knight.

Barber Point, July 23, 1917.

Lygus communis Knight.

Barber Point, July and August, 1917.

Lygus belfragii Reuter.

Barber Point and Wanakena, July and August, 1917 and 1920, on mountain ash (*Acer spicatum*) and striped maple (*Acer pennsylvanicum*). Knight records the insect upon *viburnum acerifolium, Cornus alternifolia, Conium maculatum* and also *Acer spicatum.*

Lygus hirticulus Van Duzee (Fig. 29, *b*).

Breeds on beech and yellow birch. Common. Barber Point, Plains and Wanakena during June, July and August. The winter is passed in the egg stage and only young nymphs were observed

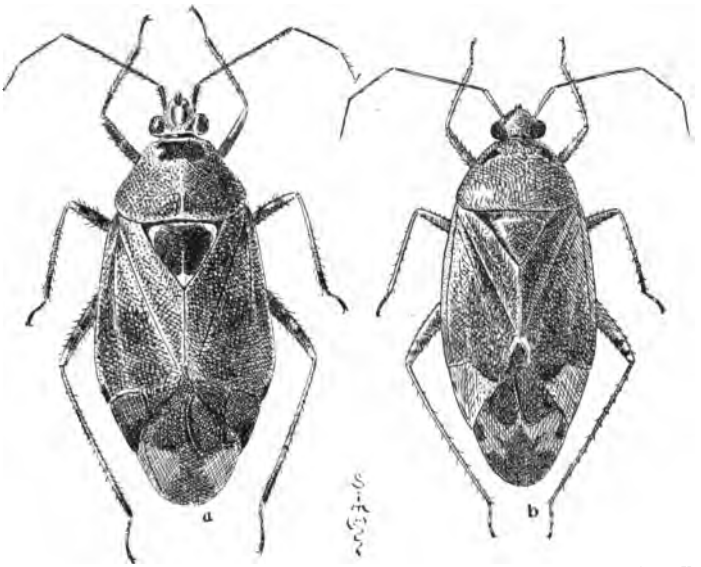


Fig. 29.— *a, Deraeocoris borealis* Van D.; *b, Lygus hirticulus* Van D.

in early spring. Knight records the species from chestnut, beech and woodbine in New York.

Lygus canadensis Knight.

Breeds on hazelnut, *Corylus rostrata* Ait., taken near the old "French Camps" at Wanakena, July and August, 1917 and 1920. This is the first record for New York State.

Lygus ostryae Knight.

On ironwood (*Ostrya virginiana*), Barber Point, July 5, 1920.

Neoborus amoenus (Reuter).

Barber Point, July, collected on white ash, *Fraxinus americana.*

Neoborus pubescens Knight (Fig. 30, *a*).

Very abundant on white ash seedlings and saplings in the vicinity of Crataegus Hill at Barber Point during June, July and August, 1919 and 1920. This insect lives in shady places and feeds almost entirely on the very young trees. It occurs in large numbers and the leaves are greatly discolored from feeding punctures. On the upper surface of the leaves the feeding marks show

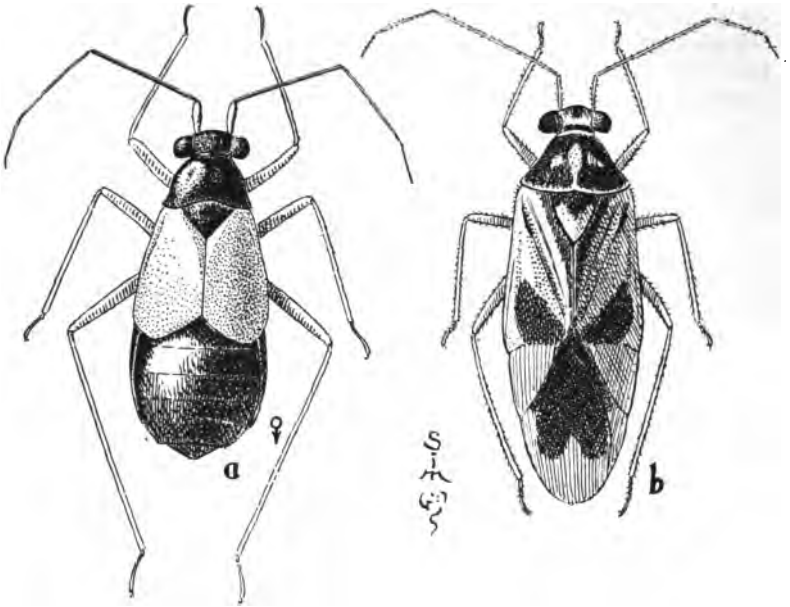


Fig. 30.— *a*, *Mecomma gilripes* Stal; *b*, *Neoborus pubescens* Knight.

up as small, conspicuous whitish areas (frequently very many spots close together) and on the under side they are of a yellowish or brownish color and much less prominent.

Deraeocoris nebulosus (Uhler).

Barber Point, July 19, 1920. Plains, July 25, 1920.

Deraeocoris borealis (Van Duzee) (Fig. 29, *a*).

Several specimens, collected at Barber Point during July and August, on beech yellow and white birch, *Salix* pp., maple and alder. This insect is largely predaceous and feeds upon plant lice. It also sucks up the droppings of "honey dew" of the aphids. On yellow birch we found it living in the woolly aphid, colonies, that cause the curled or wrinkled leaves. Its color greatly resembles that of the woolly aphids during its nymphal instars. Osborn took an adult feeding on a large nymph of a cercopid, *Closliptera obtusa,* on yellow birch at Barber Point.

Deraeocoris pinicola Knight.

Very common on white pine, *Pinus strobus,* at Barber Point, during June, July and August, 1919 and 1920. Specimens are also at hand from Conifer, Plains and Wanakena. The latter specimens were probably swept from larch and spruce.

Deraeocoris laricicola Knight.

Taken on larch, Grasse River Bog, by Osborn.

Deraeocoris fasciolus Knight.

Wanakena, July 1–7, 1917, Barber Point, July 26, 1920.

Monalocoris filicis (Linnaeus).

Barber Point, Plains, and Wanakena, June, July and August, 1919 and 1920.

Hyaliodes vitripennis (Say).

Several specimens. Barber Point, Wanakena and Plains during June, July and August. Adults were swept from yellow birch and beech at Barber Point.

Dicyphus agilis (Uhler).

Sweeping ferns. Barber Point and Wanakena, July and August, 1917 and 1920.

Dicyphus famelicus Uhler.

Barber Point, August 1, 1917.

Dicyphus vestitus Uhler.

Sweeping ferns in shady places at Barber Point and Wanakena, July and August, 1917, 1919 and 1920. Specimens are also at hand from Conifer and Wanakena.

Macrolophus separatus (Uhler).

One female, taken at Wanakena, July 15, 1920.

Labops hirtus Knight.

Numerous short-winged and a few long-winged forms, taken on grasses and weeds at Barber Point, Wanakena, Plains and Conifer during June, July and August, 1917, 1919 and 1920.

Strongylocoris stygicus (Say).

Many specimens swept from grasses and weeds in small open areas. Barber Point, Wanakena and Plains during June, July and August.

Pilophorus amoenus Uhler (Fig. 31, *a*, *b* and *c*).

Collected on *Salix* spp., yellow birch, beech, maple, and white pine, also sweeping herbaceous plants. This is common during June, July and August and is probably predaceous.

Ceratocapsus modestus (Uhler).

Wanakena, August 1–7, 1917.

Ceratocapsus pumilis (Uhler).

Barber Point, Plains and Wanakena, July and August, 1917 and 1920. Specimens were swept from willow and grasses at Barber Point.

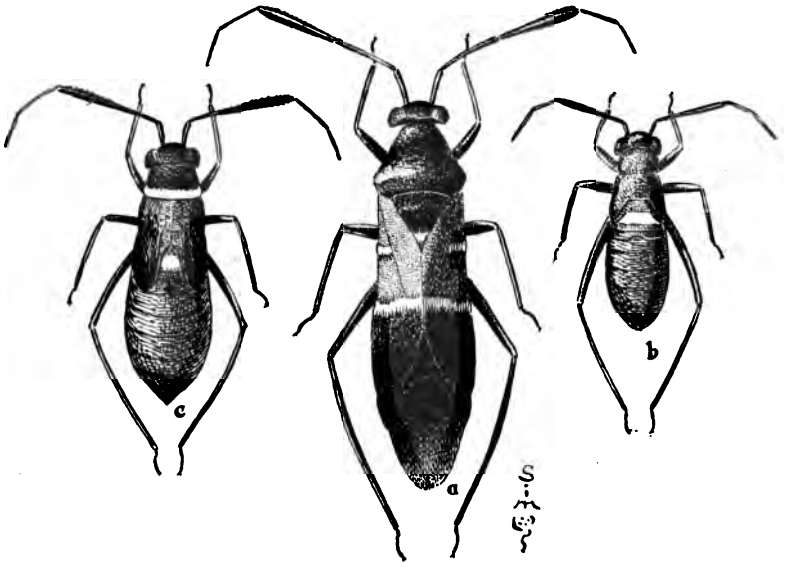


Fig. 31.— *Pilophorus amoenus* Uhler: *a*, adult; *b* and *c*, nymphs.

Lopidea media (Say).

Very common. Barber Point, Wanakena, Plains and Conifer. Specimens were taken on *Salix,* maple, blossoms of *spiraea,* and also by sweeping various grasses and weeds at Barber Point.

Diaphnidia pellucida Uhler.

On *Salix* spp., beech and yellow birch at Barber Point, July and August, 1917 and 1920. Breeding on hazelnut, *Corylus rostrata.* Wanakena, June, July and August, 1917, 1919 and 1920.

Diaphnidia provancheri (Borque).

On beech and yellow birch. Barber Point, August, 1920.

Diaphnidia capitata Van Duzee.

Beech and yellow birch. Barber Point, June and July, 1919 and 1920. Very common and breeds on hazelnut in company with *D. pellucida* at Wanakena during June, July and August, 1917. 1919 and 1920.

Reuteria irrorata (Say).

Cranberry Lake, August, 1917.

Orthotylus viridis Van Duzee.

Barber Point, July, 1920.

Orthotylus translucens Tucker?

On yellow birch. Barber Point, July 24, 1920.

Orthotylus dorsalis (Provancher).

Common and breeds on *Salix* spp. Barber Point, Plains and Wanakena, July and August, 1917, 1919 and 1920.

Orthotylus catulus Van Duzee.

Wanakena, August 1–7, 1917.

Ilnacora malina (Uhler).

Barber Point, Wanakena and Plains. Very common during the summers of 1917, 1919 and 1920.

Mecomma gilvipes (Stal) (Fig. 30, *a*, female).

Common in somewhat shaded, moist areas upon rank vegetation. Barber Point, Wanakena and Plains during June, July and August.

Macrotylus sexguttatus (Provancher) (Fig. 28, *b*).

Barber Point, Wanakena and Plains during June, July and August. The insect was found breeding on aster, *Aster acuminatus*, at Barber Point, during July and August, 1920.

Lopus decolor (Fallen).

Common. Barber Point, Wanakena, Conifer, and Plains during July and August.

Psallus n. sp.

Several specimens, taken at Wanakena, Plains and Barber Point during July and August, 1920.

Rhinocapsus vanduzeei Uhler.

Very common on rank vegetation along the trails at Barber Point, Wanakena and Plains during June, July and August.

Plagiognathus politus Uhler.

Barber Point, Plains and Wanakena during July and August.

Plagiognathus annulutus Uhler.

Barber Point during July and August, 1920.

Plagiognathus fuscosus Provancher.

On yellow birch. Barber Point, August, 1920.

Plagiognathus chrysanthemi (Wolff).

Several specimens, taken while sweeping weeds in the old burn near the Ranger School, Wanakena, July 15, 1920.

Plagiognathus fraternus Uhler.

Conifer, Barber Point and Wanakena during July and August, 1920.

Plagiognathus sp. I.

Wanakena and Barber Point, July, 1920.

Plagiognathus sp. II.

Wanakena and Barber Point, July and August.

Plagiognathus sp. III.

Wanakena and Barber Point, July. Knight will discuss this species and the two forms above when he publishes on the genus *Plagiognathus.*

Chlamydatus pulicarius (Fallen).

Barber Point, August, 1919.

Family GERRIDAE

Gerris remigis Say.

Common, only apterous forms being seen or captured. This insect lives in the coves of Cranberry Lake, Oswegatchie River, and it often congregates in large numbers in pools or slow-moving parts of streams. It spends the winter in the mature state.

Gerris marginatus Say.

Common. Taken on Cranberry Lake, Oswegatchie River and Bean Pond. This species is a lacustrine and fluviatile insect, but seems to prefer quiet waters.

Gerris argenticollis Parshley.

Taken in the coves of Cranberry Lake with *marginatus* and *buenoi.*

Gerris buenoi Kirkaldy.

This is by far the most abundant species of the smaller forms of the genus living in the vicinity of Cranberry Lake. Its habits and haunts are quite similar to that of *G. marginatus.*

Gerris rufoscutellatus (Latreille).

Very common. Barber Point, Wanakent, Plains, and Conifer. This insect hibernates over winter in the mature form and is among the first of the water-striders to appear in early spring. The eggs are deposited just beneath the surface film of the water upon floating leaves of aquatic plants, small sticks and other objects in the water. They hatch in about ten days or two weeks. In an aquarium the first adults appeared thirty-four days from the time of hatching, but most of the specimens required several days longer to reach the adult state. Like the other members of the genus *rufoscutellatus* is predaceous and feeds upon small insects, and insects that happen to fall in the water and are drowned. Field observations indicate two generations a year in the Adirondacks.

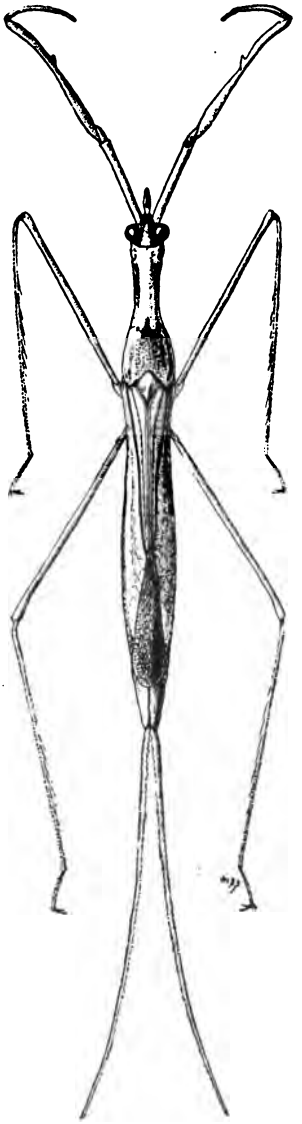


Fig. 32.— *Ranatra americana* Mont. Drawn by J. D. Smith.

Metrobates hesperius Uhler.

Very common on Cranberry Lake and the Oswegatchie River. Only the apterous form was observed. It is usually taken in company with the two following species.

Trepobates pictus (Herrich-Schæffer).

This species and *Rheumatobates rileyi* congregate by the thousands upon Cranberry Lake and Oswegatchie River. It is very variable in color and size, and occurs almost entirely in the apterous form. One deälated specimen is at hand.

Rheumatobates rileyi Bergroth.

This insect is represented by many color variations, but there does not seem to be any distinct color variety.

Family VELIIDAE

Microvelia borealis Bueno.

Several specimens, taken at Barber Point.

Microvelia buenoi Drake.

Common, collected in Bean Pond (type locality) and in the beaver meadow at Barber Point. It lives near the shore in quiet waters.

Microvelia americana Uhler.

This species is not very common and lives near the shore of streams, lakes and ponds. Barber Point, Plains and Wanakena.

Rhagovelia obesa Uhler.

Occurs in the eddies of Sucker Brook at Barber Point.

Family SALDIDAE

Pentacora ligata (Say).

Common on stones jutting out of the water in Sucker Brook in open sunny places at Barber Point.

Salda coriacea Uhler.

Proulx's Camp near Barber Point, July 22, 1920.

Saldula major (Provancher).

Very common along small streams near Proulx's Camp.

Saldula confluenta (Say) (Fig. 33, *a*).

Taken on a floating log near Barber Point and along a small stream at Proulx's Camp.

Saldula orbiculata (Uhler).

Several specimens, taken along a small stream near Proulx's Camp. I have also taken this insect on small ponds upon floating aquatic plants several feet from the shore.

Saldula interstitalis (Say).

Very common at Barber Point, Wanakena and Proulx's Camp.

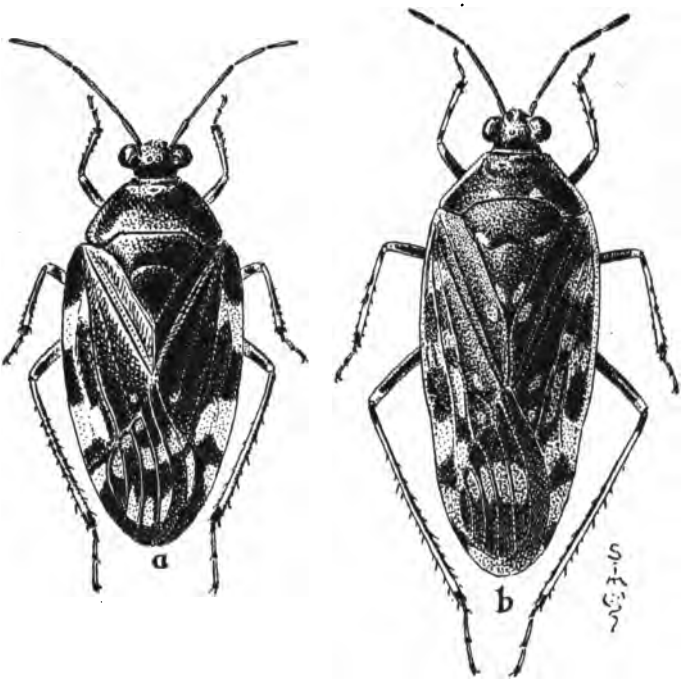


Fig. 33.— *a*, *Saldula confluenta* Say; *b*, *Pentacora ligata* (Say).

Saldula pallipes (Fabricius).

Common, collected along the shore of Cranberry Lake, Bean Pond and Proulx's Camp.

Saldula separata (Uhler).

Common along a small stream in the vicinity of Proulx's Camp.

Saldula reperta (Uhler).

Taken along a small stream in the vicinity of Proulx's Camp.

Micranthia humilis (Say).

Common near the shore of Cranberry Lake, Wanakena and Proulx's Camp. The small stream in the cut-over tract in the vicinity of Proulx's Camp offer the most favorable haunts and breeding places for the Saldidae. There are numerous small open sunny and somewhat moist places and many semiaquatic Diptera and other insects that furnish an abundant food supply. In fact there were many specimens of the Saldidae, both nymphs and adults, living near this small stream.

Family NOTONECTIDAE

Notonecta undulata Say.

Very common, taken in a stagnant pool formed by floating logs at Barber Point and Bean Pond during July, 1917, 1919 and 1920.

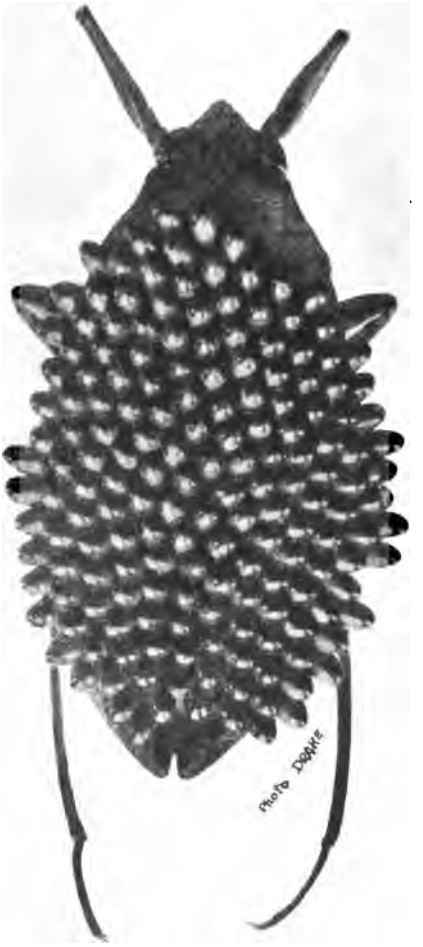


Fig. 34.— *Belostoma flumínea* Say. Male bearing eggs much enlarged. Photo by Drake.

Notonecta variabilis Fieber.

Bean Pond and Beaver Meadow, July and August.

Notonecta insulata Kirby.

Two examples from Bean Pond, July, 1919.

Buenoa margaritacea Bueno.

Many specimens from Bean Pond, 1917, 1918, 1919 and 1920.

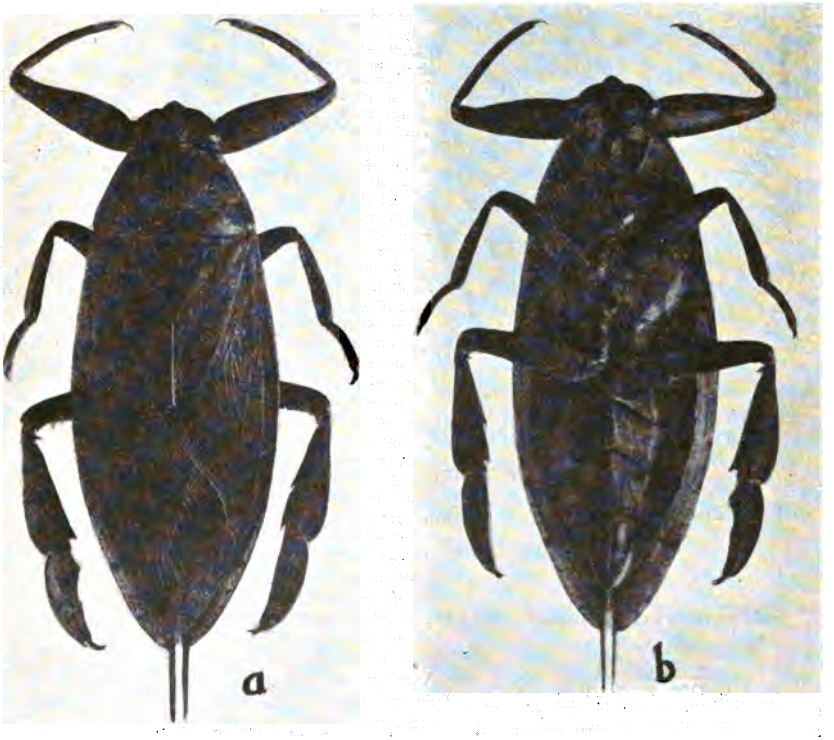


Fig. 35.— *Benacus griseus* (Say): *a*, dorsal view; *b*, ventral view. Photo by Drake.

Family NEPIDAE

Ranatra americana Montadon (Fig. 32).

Nymphs and adults, collected during July in Bean Pond and coves of Cranberry Lake. In Cranberry Lake the specimens were taken near the shore among a lot of small sticks and other debris.

Family BELOSTOMIDAE

Benacus griseus (Say) (Fig. 35).

Not common, collected in Bean Pond and coves of Cranberry Lake near Barber Point.

Belostoma fluminea Say (Fig. 34, male and eggs).

Bean Pond and Cranberry Lake near Barber Point. A specimen from Columbus, Ohio, is photographed.

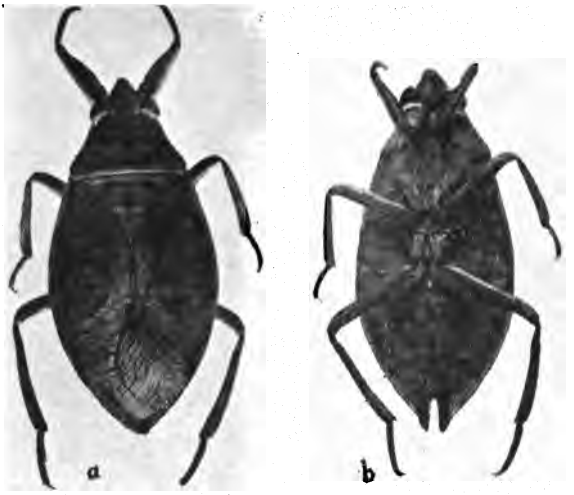


Fig. 36.— *Belostoma fluminea: a*, dorsal view; *b*, ventral view.

Family CORIXIDAE

Callicorixa praeusta (Fieber).

A long series from Bean Pond, Beaver Meadow and coves of Cranberry Lake.

Palmacorixa buenoi Abbott.

Cranberry Lake near Barber Point.

Artocorixa scabara Abbott.

Two specimens from Bean Pond, Wanakena.

Arctocorixa compressa Abbott.

Taken in Cranberry Lake near Barber Point.

CONTRIBUTION TOWARD THE LIFE HISTORY OF GALEATUS PECKHAMI ASHMEAD

By Carl J. Drake

This curious and interesting American insect was described by Ashmead (1887, p. 156) as *Sphaerocysta peckhami* from two specimens collected near Milwaukee, Wisconsin, by Prof. Geo. W. Peckham. A number of years later Van Duzee (1889, p. 5) records the insect from an island in Muskoka Lake, Canada, and transfers it to the Genus *Galeatus* Stal, where the species correctly belongs. In regard to its habitat Van Duzee (*l. c.*) says: "Swept from low weeds — probably a dwarf vaccinium or a species of aralia, which were growing close together — among pines on a rocky island" (collected between July 25 and August 3, 1889).

Uhler* (1904, p. 362) greatly extends the range of *G. peckhami* and lists the insect from Las Vegas, Hot Springs, New Mexico (collected by Schwarz and Barber, August 3, at an altitude of about 6,770 feet). Bueno (1915, pp. 278 and 279) enumerates the species among the insects taken in beech drift of Lake Superior at Marquette, Michigan, in July by Mr. John D. Sherman, Jr. The latter lot contained thirty-two specimens, which seems to indicate that the insect must have been migrating in considerable numbers. The species has recently been reported from Maine (Parshley, 1917, p. 55), New Hampshire (Parshley, 1916, p. 105) and New York (Drake, 1918, p. 86). Dr. H. H. Knight has kindly sent me a few specimens from Duluth, Minnesota. In addition to most of these records Van Duzee (1917 b, p. 216) catalogues the insect from Manitoba and Uhler (1896, p. 265) also records the species from Japan.

During the past summer (1920) Dr. Osborn and the writer found the insect breeding in great numbers upon aster, *Aster macrophyllus* L., and boneset, *Eupatorium* sp. (*fide* Dr. H. P. Brown) on the summit of Crataegus Hill, Barber Point, during the last week of July. At this time all the nymphs had attained the mature state. A careful examination of the ventral surfaces of the leaves of the asters revealed the cast-off skins of four different instars still clinging to the leaves. The skins of the last three instars were in almost perfect condition and the figures and descriptions of the nymphal instars have been made from these cast-off skins.

The eggs of *Galeatus peckhami* Ashm. are almost entirely inserted in the stem of the host plant, usually somewhat near the surface of the ground, upon which the insects are feeding. They are generally placed singly (Plate IV, Fig. *e*) and in no definite

* Horvath has recently described this form from New Mexico as a new species of *galeatus*.

order in the stems of the plants. Only a small portion of the egg or the neck-like structure and cap protrudes from the plant. However, occasionally two or rarely three eggs are inserted in the same slit or egg puncture. Sometimes five or six or even a dozen eggs may be laid in rather close proximity to each other. They are deposited during the latter part of July, August and September. In proportion to the size of the abdomen the eggs are quite large and only a few fully formed ova can be contained within the body of the female at the same time. This probably accounts for the long period of egg-deposition. There is but a single generation a year in the Adirondacks and field observation indicates conclusively that eggs, which are laid during the latter part of the summer do not hatch until the following spring. Asters, in which eggs had been deposited in the stems in the field, were transferred to small pots and placed in the laboratory at Syracuse. Adult males and females were also carried to Syracuse on the host plants, but all died during the latter part of September and October. The plants were destroyed by mildew during November and December. The eggs, which had been deposited during July or later, failed to incubate in the laboratory, but seemed to have remained in a living state until they were destroyed by desiccation of the stems of the asters a few weeks after the plants had been killed by the mildew.

The egg (Plate IV, Fig. *e*) is slightly curved, from .7 to .8 mm. long and about one-third as wide. The cephalic end is distinctly neck-shaped and closed by a round cap or lid. The color varies from brown to dark brown or black, usually considerably darker on the cephalic half and with a much lighter cap.

Number of Instars: Exuviae, representing four different instars, were found clinging to the ventral surface of the aster leaves during August. This material seems to indicate five instars, but the cast-off delicate skins of the younger nymphs were badly mutilated and in no condition for a drawing or detailed description. The cast-off skins of the last three instars were very common and many were in almost perfect condition. Although I have assumed five instars, I am not positive whether there are four or five nymphal stages.

Second Instar?: Antennae stout, clothed with a few long setae, the third segment about a third longer than the fourth. Head with five slender bristle-like spines. The spines along the margins of the thorax and abdomen, also median erect ones, slender and bristle-like. The spines on the head are located in this instar and also in the others as in the adult insect. The spines on the thorax and abdomen are placed as in the two following instars (the position and location described in next instar), but some are wanting in the last instar. Some of the bristle-like spines on the abdomen are double (two arising from almost the same base). Nine abdominal segments visible above. General color testaceous, with very few or no brownish markings.

Third Instar? (Plate IV, Fig. *k*): Cephalic spines moderately long blunt, the median one usually a little longer than the others. Antennae stout, the third segment about one and three-fourths times the length of the fourth. Outer margins of pro-, meso-, and metathorax on each side armed with a long spine; the middle of both pro- and mesothorax with an erect spine on each side of the median line. Abdominal segments two, three, four, five, six, seven and eight armed on each side near the postero-outer margin with a long spine, the ninth segment with two long spines; segments two, five, six and eight each armed with an erect spine on the median line, usually two or three or all these spines with a double-pointed tip. The spines in this instar are rather stout and blunt. Length, 1.1 mm. General color testaceous, with a few small brownish spots.

Fourth Instar? (Plate IV, Fig. *i*): Spine on head thorax and abdomen arranged as in the preceding instar, but all much longer and pointed. Body and spines sparsely clothed with moderately short spine-like structures with a bulbous or knobed tip. Antennae with the third segment a little less than twice as long as the fourth. Mesothorax distinctly larger than in the preceding instar. Length, 1.65 mm. General color testaceous, with small brownish areas at the base of some of the spines. Spines more or less brownish.

Last Instar (fifth?) (Plate IV, Fig. *f*): In this stage the spines on the head and thorax are longer than in the preceding instar. The spine-like structures with bulbous tips are also a little longer and more numerous. (Plate IV, Figs. *h* and *i*.) Pronotum large, the posterior process subtruncate. Mesothoracic wing pads large, somewhat leaf-like, projecting on the fifth abdominal segment and completely covering the metathorax and metathoracic wing pads. Abdominal segments two and three with the marginal spines wanting, also spines along margin of metathorax. Spines along the median line of the pro- and mesothorax and median spines of abdomen, especially prothoracic ones, with raised somewhat bulbous areas at the base. Antennae slender, clothed with several setae, the second segment twice the length of the fourth. Occasionally, one of the spines on the head or abdomen are double (two spines arising from almost the same base). A couple specimens in both the fourth and fifth instars have been found with an extra spine on the head (six spines) and one or two extra on the abdomen. As a rule, however, the number of spines seem to be quite constant. Length, 2.8 mm. General color testaceous, variegated with brown or fuscous. Spines more or less brownish.

The adult of *Galeatus peckhami* is only known to occur in the macropterous form. Several Palaearctic species are found in both brachypterous and macropterous forms. The head normally bears five long spines and it is very rare that one finds an individual with six spines. The posterior extension of the pronotum is somewhat inflated and the median carina is well developed. The hood is rather high, not broad and covers the base of the head.

The lateral carniae are enormously developed, somewhat ovoid in outline and form sort of a discal hood-like structure. They extend considerably above the median carina, with the front margins in contact with each other, the posterior ones distinctly separated, and each constricted near the middle above. The areolae of the hood, carinae, paranota, posterior extension of pronotum and elytra are very large. The nervures are brownish or fuscous, the areolae are mostly hyaline, sometimes a few slightly clouded. The length varies from 4.2 mm. to 4.5 mm.

Four predaceous insects, *Podisus serieventris* Uhl. *Podisus modestus* Dall., *Nabis rufusculus* Reut. and *Nabis roscipennis* Reut. were collected on the same plants with *G. peckhami.* In fact the eggs of *Nabis rufusculus* were found in stems of the asters near the eggs of *G. peckhami.* Two associated forms, *Macrotylus sexguttatus* Prov. and an undetermined aphid, were feeding and breeding in considerable numbers on the same asters. The insect lives in dry and somewhat open places; it was only taken on the crest of this small hill and seemed to be very locally distributed. It is not know whether the adults survive the winter or not. Data seems to indicate that the winter is spent in the egg stage.

PLATE IV

Galeatus peckhami Ashmead

Fig. *a*, dorsal view of adult.
Fig. *b*, lateral view of adult showing pronotum and head.
Fig. *c*, male genitalia showing claspers.
Fig. *d*, ventral view of female genitalia.
Fig. *e*, eggs in stem of aster. Part of the stem has been removed to show how deeply eggs are inserted in plant. Note how stem is slit for the insertion of an egg.
Fig. *f*, dorsal view of last nymphal instar (5 instar?).
Fig. *g*, large spine of last instar greatly enlarged.
Fig. *h*, small bulbous-like or spine-like process with knobbed tips (from last instar). These structures are found on the body and large spines (greatly enlarged) of larger nymphs.
Fig. *i*, dorsal view of nymph of third(?) instar.
Fig. *j*. dorsal view of nymph in next to last instar (fourth instar?).

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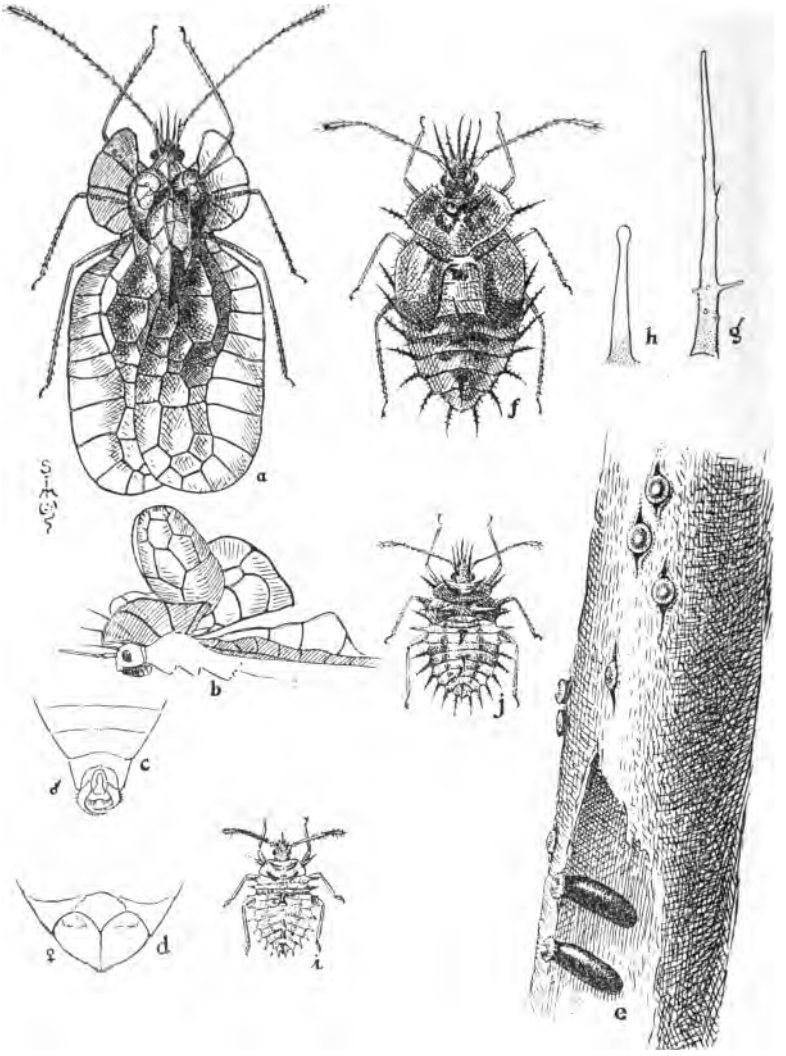

Plate IV.

THE LIFE HISTORY OF THE BIRCH TINGITID, CORYTHUCHA PALLIPES PARSHLEY

By Carl J. Drake

The yellow birch tingitid made its appearance under three different names — viz., *pallipes* Parshley, *cyrta* Parshley and *betulae* Drake — in the same paper by Gibson (1918, pp. 69–105) on the study of the Genus *Corythucha* Stal. According to pagination *pallipes* has page-priority and is the valid name for the species. Parshley (1920, pp. 28 and 29) has recently pointed out the fact that *cyrta* and *betulae* are identical. Dr. Parshley has kindly loaned me the type series of *pallipes* and *cyrta* and we are fully convinced that *cyrta* and *betulae* are not only specifically the same, but also synonymous with *pallipes*. Although *cyrta* and *betulae* can be connected up in the type series, Gibson (*l. c.*, p. 86) failed to observe this identity. Lack of food-plant data and a series showing variability accounts for the original failure to note the kinship of *pallipes* and *cyrta*.

The yellow birch tingid is undoubtedly the most common species of Heteroptera living in the vicinity of Cranberry Lake. It seems to show a decided preference for yellow birch, *Betula lutea* Michx. f., but it is also very common on white birch, *Betula alba* L., beech, *Fagus grandifolia* Ehrh. and ironwood or hop hornbean, *Ostrya virginiana* Mill. K. Koch. Dr. Osborn noted a young mountain ash, *Pyrus americana* (Marsh) DC. badly infested by *pallipes* at Barber Point in July. The writer also found the insect breeding on mountain maple, *Acer spicatum* Lam., soft maple, *Acer saccharinum* L., hard maple, *Acer saccharum* Marsh, and striped maple or moosewood, *Acer pennsylvanicum* L., but the species seems to breed only occasionally and never in large numbers on maples. The type series of *pallipes* (1918, Parshley in Gibson, p. 86) were collected on an introduced willow, *Salix sieboldiana*, at Stanford, Connecticut, by Mr. W. E. Britton. I have seen several other specimens, bearing the same date, locality and food-plant, that must have been collected with the types by Mr. Britton. The number of specimens would seem to indicate that the insect must have been at least feeding and perhaps breeding on the introduced willow. The insect has not been observed to feed or breed on the willows (growing near badly infested birch trees) in the Cranberry Lake region. Parshley (in Gibson, 1918, p. 85) also states that this insect (under *cyrta*) has been taken on sphagnum, but does not list this as a food plant. Two or three published records report *Corythucha juglandis* Fitch upon birch, but these probably refer to *pallipes*. In fact I have seen *pallipes*, bearing food-plant label "birch", in a few collections wrongly determined as *C. juglandis* Fitch. *Corythucha pergandei* Heidemann and *Corythucha heidemanni* Drake occasionally feed and

breed on birch, but alder is by far the most common and the preferred food-plant of these species.

Distribution: *C. pallipes* is a transcontinental species and probably occurs throughout the northern part of the United States and southern Canada. Specimens are at hand from New York, Massachusetts, Maine, New Hampshire, Connecticut, Michigan, Wisconsin, Oregon, Washington and Canada (Ottawa and Manitoba).

Variation: Like a number of its congeners, *pallipes* shows considerable variation in size, shape of the hood, and also in the relative proportion of the height of the crest of the hood with the height of the median carina. There is also a moderate degree of variation in size and general color of the entire insect. This variation accounts largely for the synonomy of the species. The adult insect ranges from 3.5 mm. to 4.32 mm. long. In relation to the median carina, the height of the crest of the hood varies from about twice to approximately three times that of the median carina. The posterior portion of the hood also varies considerably in width. On the same food plant one can find the extremes of variations as well as gradual gradations leading to all intermediate forms. There seems to be no distinct varieties, but the most common form generally has the hood a little larger than the type (*pallipes*). There is also a little variation in the height of the lateral carina.

Injury (Fig. 45): This tingid occurs on the yellow birch trees by the thousands and it is undoubtedly the most injurious leaf-feeding insect upon the yellow birch tree in the vicinity of Cranberry Lake. Although large trees are frequently infested it seems to prefer the younger trees and seedlings. During the summers of 1917, 1918, 1919, and 1920 the insect has been especially abundant in the vicinity of Barber Point. Numerous young birches were so badly infested that the leaves were almost entirely discolored by its feeding punctures. In fact, the discolored leaves of badly infested trees by the last of July would attract one's attention several yards away. Later, many of these leaves would be almost entirely destroyed. Ironwood probably ranks next to yellow birch as a preferred food-plant, but white birch and beech are often badly infested. Mountain ash and the various species of maples do not seem to attract the insect very frequently and never in great numbers; in fact they are very rarely infested at all. There are two generations a year in the Adirondacks, the second generation hibernating as adults over the winter among the fallen leaves on the ground.

The adults and nymphs feed almost entirely on the under-side of the leaves (Fig. 45). The young nymphs, especially during the first and second instars, feed largely in colonies, but they gradually scatter during the older stages. The discoloration, caused by the feeding of the insects, is very conspicuous on both sides of the leaves (Fig. 45). In addition to these discolored and feeding areas there are small blackish spots on the under-side of the leaves where the faeces have been deposited.

Natural Enemies: Two predaceous insects, a little anthocorid, *Anthocoris borealis,* and the larvae of a lace-winged-fly, *Chrysopa* sp., were observed feeding upon both nymphs and adults in the field. Adults are also occasionally parasitized by a small red mite, *Trombidium* sp., the latter usually being attached to the ventral side of the abdomen.

Eggs: The eggs are deposited on the under-side of the leaves in the axil of the veins. They are placed on end (only the base of each egg being slightly inserted in the tissue of the leaf) and in no definite order, but usually in groups ranging from four to ten eggs each. Sometimes only one and at other times about a dozen or more eggs are laid in a single group. The eggs are fairly well concealed on yellow birch leaves by the pubescence along the veins of the leaves.

The egg (Plate V, Fig. *e*) is sub-elliptical, slightly curved, about .6 mm. long and not quite one-third as wide. The cephalic end is somewhat constricted and closed by a cap or lid. The color varies from brown to a very dark brown, but the cap is always much lighter and of a grayish color. They hatch about ten days after deposition.

First Nymphal Stage (Plate V, Fig. *d*): Much more cylindrical elongate, and thicker than in the other instars. Antennae composed of three segments, the third long and with a few long setae. Head with five tubercles, the anterior pair with a single spine on each, the median and the posterior pair with two spines on each. Abdominal segments two, three, four, five, six, seven, eight and nine with a small tubercle, bearing a slender spine, on each side. Both pro- and mesothorax armed on each side with a spine. Abdominal segments two and eight bearing a pair of small dorsal tubercles with a spine on each; segments five and six with large and prominent dorsal tubercles, each tubercle bearing three slender spines. Mesothorax also with a dorsal pair of tubercles, each bearing a slender spine. Length, .61 mm.; width, .15 mm. At time of hatching the nymph is almost colorless. Fully matured specimens are of a rather dark brown color. This instar lasts from four to six days.

Second Nymphal Stage (Plate V. Fig. *e*): Body broader in proportion to its length than in the preceding instar. The tubercles on the head are a little larger. The spines along the margin of the abdomen are stronger and larger and the spicules are more numerous over the entire body. Length, .75 mm.; width, .43 mm. Color, dark brown. The length of this instar varies from five to ten days.

Third Nymphal Stage (Plate V, Fig. *f*): Antennae with four segments. The pro- and mesothorax larger and the entire insect more oval in outline. A few small spines have appeared on the tubercles. Length, 1.01 mm.; width, .64 mm. General color, dark brown. Length of instar, four to eight days.

Fourth Nymphal Stage (Plate V, Fig. *g*): Tubercles moderately large, each bearing several spines. Prothorax considerably larger, the mesothoracic wing-pads quite prominent. Small spicules have appeared on the bases of large spines. Length, 1.68 mm.; width, .76 mm. General color, dark brown, the base of the abdomen with a lighter area. Length of instar, five to twelve days.

Fifth Nymphal Stage (Plate V, Fig. *h*): Tubercles on the head quite large and prominent, each bearing several spines. Tubercles and spines much larger. Spinules present as in the preceding instar. Prothorax very prominent, the median anterior portion considerably raised and inflated, mesothoracic wing-pads very large, completely covering metathoracic wing-pads and extending on the fourth abdominal segment. Spines on lateral margins of abdominal segments covered by wing-pads wanting. Length, 2.2 mm.; width, 1.3 mm. The general color is dark brown, the yellowish areas on the prothorax, wing-pads and base of the abdomen have increased in size. Length of instar, eight to fifteen days.

PLATE V

Corythucha pallipes Parshley

Fig. *a*, adult.
Fig. *b*, lateral view of hood and median carina.
Fig. *c*, egg.
Fig. *d*, first nymphal stage.
Fig. *e*, second nymphal stage.
Fig. *f*, third nymphal stage.
Fig. *g*, fourth nymphal stage.
Fig. *h*, fifth nymphal stage.
Fig. 45, Yellow Birch Leaves showing eggs, nymphs and adults. Note discolored areas caused by feeding punctures.

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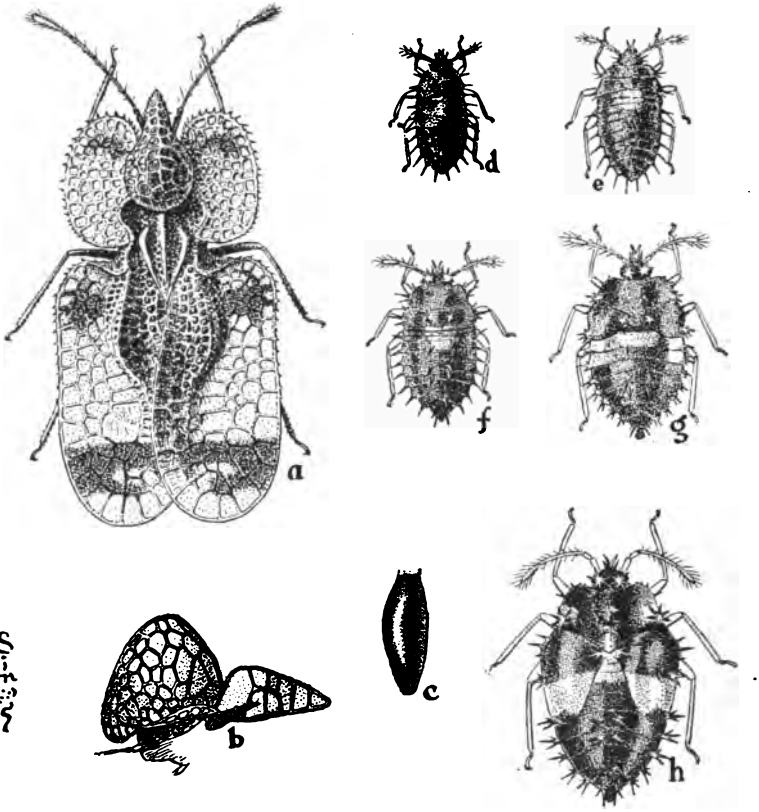

Plate V.

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